ENGINEERING CONSTRUCTION WEEKLY

MAY 13 1940

ENGINEERING NEWS-RECORD

MAY 9, 1940

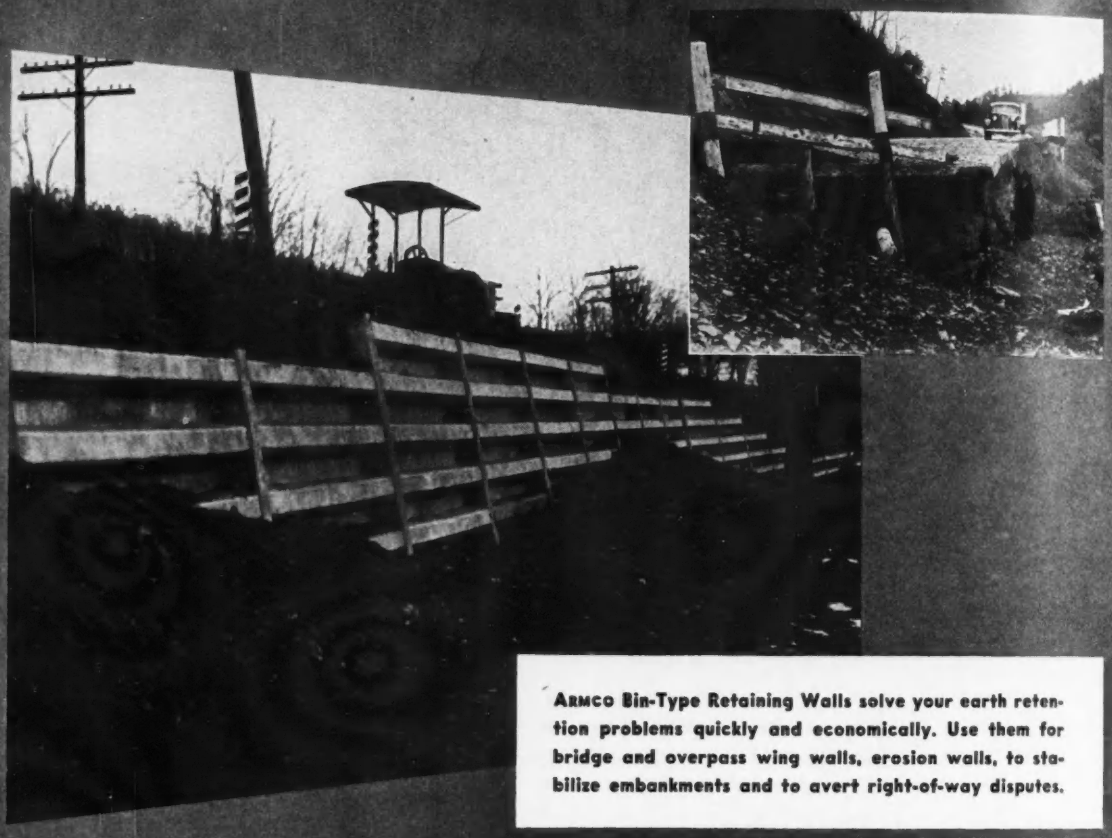
Levees for Lake Okeechobee

New York's East River Drive

Rio Grande Water Storage Project

Wrecking a Chicago Landmark

Here's A Permanent Cure
FOR "WEAK-KNEED" ROADS



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THIS WEEK

● Drill boats and dredges are creeping along the southeast shore of Lake Okeechobee, breaking up soft rock on the lake bottom and pumping it high up on the shore to create higher levees. In this way the U. S. Engineers plan to foil the high winds which in the past have blown a good share of the shallow lake's water into the low country adjoining.

● Double-deck covered roadways and a cut-and-cover tunnel are two outstanding features of the newest link in an express road system which eventually will belt Manhattan Island. The story of East River Drive is told on page 68.

● Construction stories, rather than destruction stories, are usually to be found in the pages of *News-Record*. However, there is news in one destruction job, and this news is told in "Wrecking A Chicago Landmark." The landmark is the old Great Northern Hotel, one of the nation's first steel frame buildings.

● As the Mexicans have awakened to the possibilities of using lower Rio Grande water for irrigation on their side of the border, American growers in that region are faced with water shortage, unless something is done. That "something" promises to be a $60,000,000 diversion canal and reservoir project. See p. 90.

THINGS TO COME

Wire Rope for Construction

WIRE ROPE is the lifeline of many a construction job yet it is incompletely understood by its host of users. To the improvement of this situation will be dedicated an 8-page section of the May 23 issue. Illustrated with photos of typical installations and cross-sections of the most-used constructions, the section will be a manual well worth saving. Wire rope design, manufacture, tests, selection and care will be discussed fully.

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ENGINEERING NEWS-RECORD

NEWS

Volume 124 MAY 9, 1940 Number 19

Penn. Legislature Gets Turnpike Extension Bills

Enabling legislation for extension to Philadelphia of the Pennsylvania superhighway being built between Pittsburgh and Harrisburg has been included in the bills before the special session of the Pennsylvania State Legislature, which convened May 6. The proposed work would cost $50,000,000.

• • •

Lake Diversion by Illinois Fought by Six States

Attorney generals of New York, Wisconsin, Pennsylvania, Ohio, Michigan and Minnesota met in Chicago May 2 to map a fight against Illinois' plea before the U. S. Supreme Court that it be allowed to increase diversion from Lake Michigan from 1,500 to 5,000 cfs. The attorney general of Illinois has asked that 5,000 cfs diversion be permitted until completion in 1942 of the West Side disposal plant by the Chicago Sanitary District.

The states fighting the diversion point out that the Supreme Court and the War Department orders were to the effect that the disposal plant should be completed in 1935.

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Contractor Pays Damages For Water Contamination

One hundred suits totaling $250,000 against the Carey-Reed Construction Co., Lexington, Ky., by residents of Cleveland, Miss., for admitting water from Jones Bayou into the city's water mains have been settled for an aggregate of $11,000.

The litigants instituted proceedings against the company in December, 1937, when the city's water was contaminated during the construction of Highway 61 east of Cleveland (*ENR*, Nov. 30, 1939, p. 722).

Total cost to the contractor, including court costs and $4,000 as previous awards, is estimated to be $20,000.

House Flood Control Bill Includes $191,000,000 for Dams and Local Works

Contains $37,000,000 for extension of Arkansas River project and $30,000,000 for more work on Ohio River control

The House flood control committee has reported out a bill authorizing $191,000,000 worth of flood control and local protection projects to be carried out by the Corps of Engineers as money is made available by Congress. Largest single authorization is a $37,000,000 extension of the Arkansas River project which would make the plan include the Grand and Verdigris River basins. The Ohio River authorization is increased by $30,000,000, and the Connecticut, Lower Mississippi, and Los Angeles County projects are each increased by $15,000,000. The White River project is increased

(*Continued on p. 56*)

NEW ENGINEERING DEAN AT UNIVERSITY OF MICHIGAN

IVAN C. CRAWFORD, dean of the school of engineering and architecture at the University of Kansas, has been named dean of the college of engineering at the University of Michigan, effective July 1.

Following his graduation from the University of Colorado in 1912 with a civil engineering degree, Crawford worked with the Denver & Rio Grande Western, Oregon Short Line, and the Illinois Central railways. He next joined the teaching staff at the University of Colorado, leaving in 1923 to become dean of engineering at the University of Idaho.

Beginning in 1936 Crawford served as associate consultant to the National Resources Committee, going to the University of Kansas as dean of engineering in 1937. At the University of Michigan he succeeds the late Henry C. Anderson, who died Oct. 14, 1939.

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Divided Lane Roads In Huge Quebec Program

A three-year program to provide the Province of Quebec with a modern highway system at a cost of $460,000,000 was outlined by Ernest Gohier, chief engineer of the Quebec department of roads, before the Engineering Institute of Canada late last month.

The work includes construction of a four-lane divided highway from Montreal to New York State—this road to connect not far west of Rouse's Point with a linking road built by the State of New York—and completion of the new boulevard from Montreal to St. Anne de Bellevue to join the Cote de Liesse road, which is to be widened to four lanes.

New roads are also planned to improve travel in the Laurentians between Montreal and Quebec via the South Shore and from Montreal to St. Hubert airport. In all of the work it is planned to build four-lane divided-highways wherever possible with elimination of as many curves and crossings as the money available will permit.

San Francisco Faces Knotty Power Problem

Cost of abiding by Supreme Court decision may handicap other municipal services

When the U. S. Supreme Court ruled that San Francisco was selling Hetch Hetchy power in violation of the Raker Act, the city was brought face to face with the knotty problem of becoming its own distributing agent or of discontinuing the use of Hetch Hetchy power. Either course will be expensive, and the voters have not shown a disposition to approve bond issues for power.

One of the difficulties arises from the variation in load factor. In 1939, hydroelectric plants on the Hetch Hetchy water system generated and delivered to the Pacific Gas & Electric Co. 506,000,000 kwh. This output was made on the basis of operating for maximum kilowatt-hour production. If Hetch Hetchy power were to be used in San Francisco only, where the load factor is 42 per cent as compared to more than 60 per cent on the P.G.&E. system, the useful output would have to be figured at about 400,000,000 kwh per year. As the city uses about 1,000,000,000 kwh per year, an additional 600,000,000 kwh would have to come from other sources if the city were to take over the job of supplying all electrical energy.

Many millions involved

The cost to the city of acquiring facilities for distribution of Hetch Hetchy power would range from 25 to 55 millions, according to the extent of acquisition and the terms made. When the matter last came before the voters (a year ago) the proposal was for a revenue bond issue of 55 million dollars to provide (a) a city-wide distribution system, (b) more power and stand-by service from the P.G.&E., (c) another city generating station at Red Mountain Bar below the Hetch Hetchy's principal generating plant at Moccasin Creek, and (d) leased transmission facilities for bringing city power about 45 mi. from Newark, terminus of the Hetch Hetchy transmission line, to San Francisco. This proposal was defeated by a 2 to 1 vote despite the fact that the U. S. district court had just previously ruled that San Francisco must terminate its sale of Hetch Hetchy power to P.G.&E. Blocked by the Supreme Court decision from further court appeals and having the turn-down vote on a power bond issue so freshly in mind, San Francisco officials are unprepared as yet to recommend a course of action to the voters of the city.

Engineers Protest Bidding For Professional Work

Fighting the growing tendency of municipalities to call for bids on professional engineering work, as exemplified by the recent opening of competitive bids by the city of Flagstaff, Ariz., for the design of the city's proposed $200,000 water works system, the Arizona Section of the American Society of Civil Engineers adopted a resolution authorizing the section president, Victor H. Housholder, to appoint a committee to review plans submitted to municipalities by successful bidders on professional engineering contracts. This is to determine if the professional services given to municipalities under such contracts are of the highest standards, and to advise the board of direction of the Am. Soc. C. E. of any lapse from such standards.

While the code of ethics of the Am. Soc. C. E. precludes reviewing the work of another engineer for the same client, members of the society may report unprofessional conduct such as inadequate or incomplete plans to the board of direction of the society. Under the society constitution, the board of direction is authorized to "consider proceedings looking toward the expulsion of any member upon information coming to its notice. . . ."

Not registered in Arizona

Although the Flagstaff city council awarded the contract for engineering services to a firm not registered to practice engineering in the state of Arizona as required by law, no action is contemplated either by the Arizona Section, or by the Arizona State Board of Technical Registration, due to the fact that the firm is registered in California and thereby entitled to reciprocal registration in Arizona.

The Flagstaff water supply job was awarded to Taylor and Taylor, consulting engineers of Los Angeles, Calif., both being members of the American Society of Civil Engineers.

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Contractor Gets Damages For Merritt Parkway

Peter Mitchell, Inc., highway contracting firm of Greenwich, Conn., has settled for $38,000 its $60,000 claim against the state of Connecticut as the outgrowth of a $350,000 paving contract for part of the Merritt Parkway. After the 1939 Connecticut General Assembly gave permission to the company to sue the state, Charles J. Bennett, Hartford civil engineer and a former state highway commissioner, was appointed to make an investigation of the Mitchell claim, which arose during the 1937 controversy as to whether the Connecticut public works department or the Connecticut State Highway Department had control of road contracts. The Mitchell company claimed that it was forced to incur extra expenses because it was ordered by the Public Works Department to begin work before the necessary land had been purchased by the highway department, thus changing operation plans.

Bennett, following an investigation, recommended a cash settlement out of court for $38,000. The settlement has been approved by Highway Commissioner William J. Cox, Public Works Commissioner Robert A. Hurley, and Attorney General Francis A. Pallotti.

• • •

Ozone Test Plant For Philadelphia Water

The city of Philadelphia has awarded a contract to Ozone Processes, Inc., of that city, to install a 1-mgd pilot plant at the Lower Roxborough filtration plant. Construction is to begin immediately and the ozone test plant is expected to be in operation by Aug. 1.

The plant will have a total generating capacity of 20 lb. of ozone daily available for the test work to determine the merits of ozone in purifying the city's water supply. It is estimated that the complete cost of the tests, over a period of a year, will be $25,000, of which the city has contributed $10,000 and Ozone Processes, Inc., $15,000.

Details of the ozone treatment process were published in *ENR* Feb. 1, 1940, p. 168, and Apr. 11, p. 516.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

LEGAL STATUS of standardization and grading activities of trade associations is clarified by the terms of a consent decree agreed to by the Department of Justice in its anti-trust suit against the Southern Pine Association. The decree reveals that, as was pointed out in *ENR*, Feb. 29, p. 298, the Justice Department does not consider grading as in itself illegal but wants to see that grading is not used as a means to enforce an illegal monopoly. Southern Pine Association's grading activity, under the consent decree, must be lodged in an independent autonomous bureau the services of which will be available at a fee to any member of the industry. Specifications are set up for the

(*Continued on p. 59*)

Construction Begins on Niagara Falls Bridge

Following ground breaking ceremonies May 4, construction was started on the Rainbow Bridge at Niagara Falls to replace the old Falls View Bridge, destroyed by ice in 1938. Bethlehem Steel Co. has a contract of $1,452,000 for the main arch span. Other contractors are: McLain Construction Co., Buffalo; Aikens & McLaughlin, St. Catherines, Ontario; and Cameron & Phin, Welland, Ont.

Plans for the work have been prepared by Edward P. Lupfer Engineering Co., Buffalo, with Waddell & Hardesty, New York City, consulting engineers. Aymar Embury, New York City, is architect for the project. The work is being done by the Niagara Falls Bridge Commission.

Chamber of Commerce Speakers Blend Confidence With Criticism

Charges of federal dictatorship clash with demands for conservation. Industrial leaders assert that plant modernization and housing can reemploy idle

Sharp clash of opinion over methods of conserving natural resources, particularly coal and oil, marked the annual meeting of the United States Chamber of Commerce at Washington last week. J. D. A. Morrow, president of the Pittsburgh Coal Co., criticized government attitudes toward the coal industry as destructive, while George A. Hill, Jr., president of the Houston Oil Co., attacked federal oil control. Ralph J. Watkins, chairman of the Energy Resources Committee of the National Resources Planning Board, replied that only the federal government can control the waste that results from unregulated exploitation.

Other sessions of the meeting centered on recovery problems. President W. Gibson Carey, Jr. (Yale & Towne) declared that the present economic crisis while serious, can be solved, and that industry must join in working out the solution. Corrective steps include reduction of federal expenditures, beginning to pay our debts and encouraging productivity by reducing taxes and releasing restrictions on business.

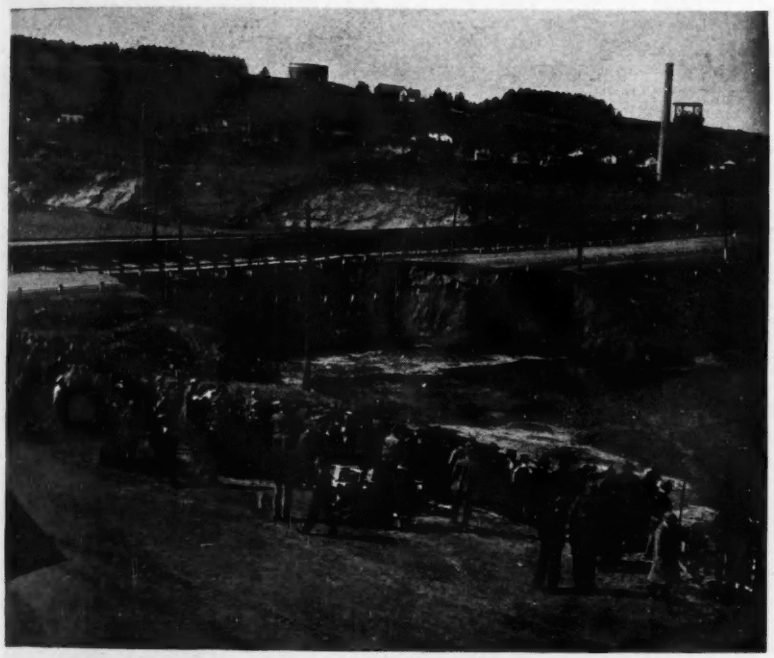
Charles E. Wilson (General Electric Co.) pilloried "the philosophy of a finished America" as defeatism and pointed out that a vast rebuilding job needs to be done. "In the process of bringing the plants of producers up to date there is opportunity to return millions of idle men to the ranks of the employed," he said, and added that this work and the provision of modern homes for the people is great enough that it can bring back prosperity. Taking the same view as Wilson on a "finished" America, H. W. Prentis, Jr., (Armstrong Cork Co.) declared that extensive industrial frontiers remain, but "when government ceases to be merely an umpire and steps into the game itself, many a player concludes that a seat on the side lines is preferable."

Natural resource development

Speaking for the coal industry, Morrow denied emphatically that it is a sick or unprogressive industry; its miseries "are the direct and inescapable consequences of unsound and destructive governmental policies." Taxing the reserves of unmined coal in the ground forces wasteful exploitation, he said; taxes on coal should be levied only as it is mined. The bituminous coal act with its fixing of minimum prices is a monstrosity that will make worse the ills that it is supposed to cure, Morrow stated. He proposed that the coal industry be permitted under federal supervision to enter into voluntary associations for research, production and sale. Similar principles apply to other natural resource industries, he asserted.

Proposed federal oil control legis-

(*Continued on p. 57*)



THE BOTTOM REALLY DROPPED OUT OF THIS ROAD

A 150-ft. section of U. S. Highway 2 in the city of Iron Mountain, Mich., May 3, settled into 80 ft. of water covering a cave-in mine area, four passenger cars and a truck going down with the road. No one was killed. Tracks of the Chicago & Northwestern and the Chicago, Milwaukee, St. Paul and Pacific railroads shown in the background were not affected.

The area has been sinking for about forty years, with the highway and railroad fills being progressively built up; the highway fill was 110 ft. high at the time of the slide. The side slopes on the railroad fills are terraced; those on the road fill were merely sloped with an inclination steeper than 2 on 1.

Until two years ago the railroads and the city cooperated in pumping water from the pit at a rate of 3 mgd. Since then it has been accumulating until it is now 80 ft. deep including a 15-ft. rise in the past six months. This, coupled with the fact that about 15 ft. of frost left the ground during the past few weeks, is seen as a cause of the slide since highway engineers report no further cave-ins of the mine workings.

A few days before the slide occurred, A. H. Proksch, Iron River, Mich., had started work on a contract to repair and extend the fill.

Turnpike Tunnel Builder Asks for More Pay

Hunkin-Conkey Construction Co., Cleveland, contractor for the construction of the Laurel Hill tunnel and approaches on the Pennsylvania express highway being built between Harrisburg and Pittsburgh, has filed a civil suit in the federal court at Scranton, Pa., against the Pennsylvania Turnpike Commission seeking $463,000 as additional pay.

The contracting firm which was awarded a $1,920,000 contract for construction of the tunnel last year, claims original specifications for the tunnel were inadequate and the quantity of steel which the Turnpike Commission estimated for the work was much below that actually required, making construction work in accordance with original plans and specifications impossible and necessitating additional costs.

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Flood Control Funds

(*Continued from p. 53*)

$13,000,000, the Willamette River $8,500,000, and the Missouri project $5,000,000.

Major newly authorized projects include the following: local protection, Tennessee River, $13,500,000; Pine Flat Reservoir, Kings River, California, $5,000,000; Whitney Reservoir, Brazos River, Texas, $5,000,000; Allatoona Reservoir, Coosa River, Georgia, $3,000,000; Lower Colorado improvement, Texas, $2,000,000; San Angelo Reservoir, North Concho River, Texas, $2,000,000; Cherry Creek improvement, Colorado, $3,000,000.

Conditions of local contribution (right of way and easements) to local flood protection are stiffened somewhat and modified to speed up carrying out of this type of project. Previous flood control laws permitted the President to waive 50 per cent of the local contribution from Ohio River communities if they were unable to put up the money; Paducah, Brookport, Golconda, and Jeffersonville took advantage of this. The present bill would repeal this authority.

Authorization for local protection projects would expire, the bill provides, within five years unless the community offers definite assurances that it will put up its share of the money. On the other hand, when a community raises its share before the Chief of Engineers has the money to go ahead with the project, the bill would make it possible for the community to loan the money, without interest, to the Corps of Engineers so that work could start at once. This provision, similar to an existing clause in river and harbor law, is aimed particularly at the city of Cincinnati where a $5,000,000 bond issue authorization is about to expire.

Similarly aimed to expedite the flood control program is a provision empowering the Chief of Engineers, if he finds that the amount authorized is not enough to complete a project, to go ahead with preliminary work such as land-purchase, site-clearance, and foundation-construction. He may also build a smaller structure at the same site provided this is so designed as to be capable of later expansion to the dimensions of the original project.

A NEW FACE APPEARS IN NEW YORK'S FINANCIAL DISTRICT

THE MOST EXTENSIVE use of glass brick yet employed in a Manhattan office building, aided by soundproofing and indirect interior illumination, provides unusually efficient working conditions in the new $1,000,000 Aetna Casualty & Surety Co. building on William St., New York City, in a district of narrow streets and tall buildings that obstruct the natural light.

Scheduled to be completed in June, the structure is seven stories high with all the facade of glass brick surrounding clear glass windows, except for the area covering the structural steel framework, where limestone is utilized above the granite base. The main floor of the building is featured by a 19-ft. ceiling with glass windows rising to a height of 15 ft. above the sill. The building now contains 120,000 sq.ft. of floor space and is so designed that two extra floors may be added when necessary.

Cross & Cross, architects of New York City, prepared the plans and specifications in association with Eggers & Higgins. George H. Fuller Co., New York, is the general contractor on the work.

C. of C. Speakers

(Continued from p. 55)

lation was described by Hill as an attempt to substitute a system of regimented industry for individual initiative and free competitive enterprise. He sharply criticized statements in the energy resources report of the National Resources Planning Board as an expression of collectivistic and authoritarian policy which, according to Hill, "assumes that any imperfections in state law or state administration are guaranteed correction by mere federal usurpation."

Watkins in rejoinder "that the federal government, as the only agency representative of all of us, must assure itself that the objective of conservation of energy resources is being attained," as state regulation is bound to be ineffective.

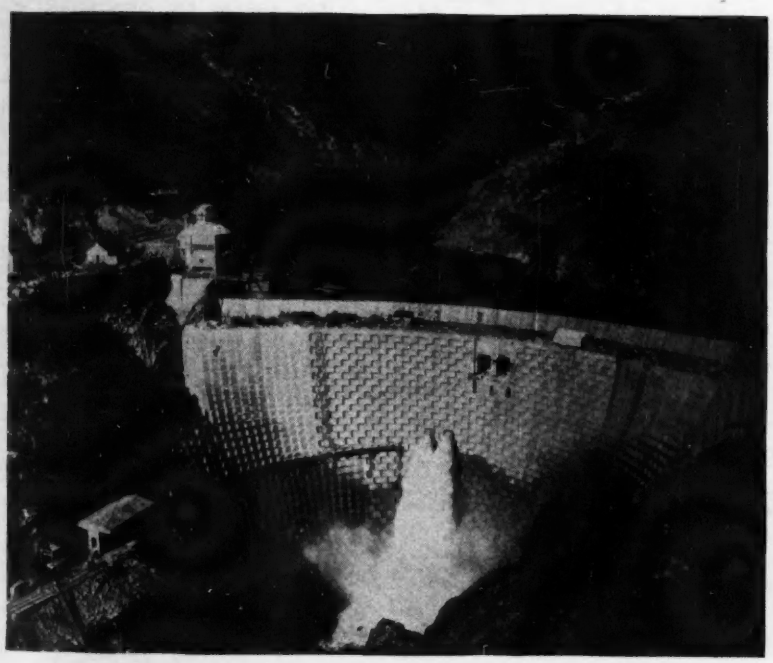
Housing and airports

A committee report on public housing declared that the country cannot afford to solve the housing problem of the lowest income families with new publicly owned housing, and urged that the USHA housing program be discontinued in favor of rent subsidies to needy families, Research to lower building costs is desirable, and private enterprise should be encouraged to rehabilitate and reconstruct rundown city areas.

Committee recommendations on airport improvement were that expenditure of federal funds on commercial airports should be subject to approval of the Civil Aeronautics Authority, and such improvements should be coordinated with extension of airline service, and should be confined to work of national interest. Aviation gasoline taxes should be devoted to civil aviation purposes.

Toll roads discussed

Discussing the highway problems touched upon in the Public Roads Administration's report "Toll Roads and Free Roads," the committee joined in the principal recommendations of that report, opposing tolls except for unusually expensive special highway structures and asking that the highway program include a system of modern free inter-regional highways as well as city entrance and bypass roads. It opposed excess condemnation.



SEATTLE OKAYS FIRST UNIT OF ROSS DAM

THE SEATTLE, Wash. Board of Public Works has accepted as complete the first unit of Ross Dam. The structure, of the variable radius arch type, has been built up to El. 1380 with the top 15 ft. consisting of a timber crib. Ultimately Ross Dam, now 290 ft. high, will be raised to El. 1515. The work was done as part of the city's Skagit River hydro-electric project by the General-Shea-Columbia Co.

W. D. Wolfendale was resident engineer on the dam for the Seattle light department; W. J. McKean, acting superintendent; and Glen H. Smith, outside engineer.

Senate Increases Interior Appropriations

Adds $11,425,000 more for Reclamation; makes other increases in 1941 appropriations

The Senate last week passed and sent to conference the Interior Department appropriation bill for fiscal 1941 with substantial increases over the House version in the amounts for construction. The upper chamber provided $11,425,000 more for Reclamation than did the House; the major increases were an additional $7,600,000 for the Central Valley project and inclusion of $5,000,000 to continue the program, begun last year, of partly reimbursible projects in cooperation with WPA. A half million dollars was added for the Parker Dam power project, and the sum for the All-American Canal was cut $650,000 to $850,000. Amount for Reclamation investigations was increased from $300,000 to $900,000.

The Senate added $1,000,000 for power installation at Bonneville.

To the $2,000,000 provided in the bill for park roads and trails and the $2,000,000 for the Blue Ridge and Natchez Trace parkways, the Senate added contract authorizations of $3,000,000 and $6,000,000 respectively. This is an increase over the budget and would bring the amount of construction up to that authorized for fiscal 1941 in the 1938 highway authorization act.

A clause was inserted by the Senate requiring that in the assignment of newly irrigated land preference be given to "Grapes of Wrath" farm families who have been forced off other farms "through no fault of their own."

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New Parkway Link Begun at New York

An $8,000,000 southern extension of the Hutchinson River Parkway in the Borough of the Bronx has been started in New York City by the Triborough Bridge Authority. The new extension will branch off from the section running through Pelham Bay Park, cross over a new bridge spanning Eastchester Creek, and continue in a southerly direction along Westchester Creek to join the present approach to the Bronx-Whitestone Bridge at Eastern Boulevard. It will be 3¾ miles in length; three lanes of traffic in each direction will be provided with the elimination of grade crossings at Baychester Ave.; Gun Hill Road; New York, New Haven & Hartford R. R., Bronx Pelham Parkway; Westchester Ave.; Tremont Ave.; Gra Ave., and Eastern Boulevard.

OBITUARY

WILLIAM J. DONOVAN, 63, civil engineer and building superintendent of the Hotel Commodore in New York City, died in Pelham, N. Y., May 1. Donovan, a graduate of the University of Tennessee with a civil engineering degree, for a time was in business with his father, Charles D. Donovan, at Nashville, Tenn. In 1900 he moved to New York to engage in various engineering projects. For a time he was a member of the engineering staff of Westinghouse, Church, Kerr & Co., consulting and contracting engineers, New York City.

EDWARD G. BAUER, former city building commissioner and engineer for the school board at Cleveland, Ohio, died last week in Youngstown, Ohio. Bauer, a native of Germany, came to the United States in 1913 to join Stone & Webster at Boston. A few years later he moved to Cleveland to work for Drummond & Miller, building contractors, before joining the engineering staff of the city of Cleveland.

JACOB H. WEIL, 76, founder of J. H. Weil & Co., Philadelphia, died in that city late last month. Weil was graduated from the University of Budapest with an engineering degree in 1883 and came to Philadelphia in 1885, to assist in laying out the old street railways of that city. In 1890 he formed the Weil firm.

THORVALD MICHAELSEN, 51, civil engineer and for the past seven years city engineer of Marshalltown, Iowa, died in that city last week. Michaelsen, a graduate of Iowa State College in 1911, was one of the founders of the Thor Construction Co., Cedar Falls, Iowa. Later he was employed by the Iowa State Highway Department.

EMIL H. PFAFFLIN, formerly assistant division engineer of the Chicago, Milwaukee, St. Paul & Pacific Railway, died May 3 at his home in Chicago at the age of 78.

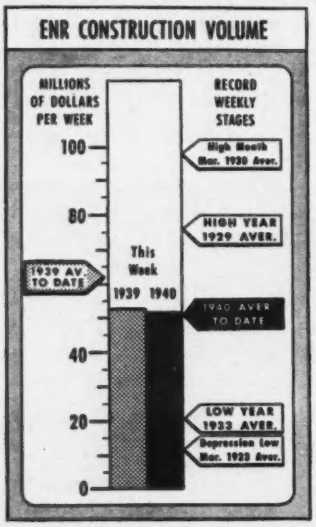
DOUGLAS KNOX, 68, retired civil engineer of Orient, L. I., N. Y., died in Honolulu May 1. For several years Knox was a member of the surveying firm of Douglas Knox & Stephen L. Garvin, Inc., New York City. He was one of the organizers of the Association of City Surveyors of Greater New York.

MILES CHAPMAN, 66, civil engineer and president of the Chapman-Price Steel Co., died April 27 in Indianapolis. Chapman, a graduate of Lehigh University with a civil engineering degree, was also chairman of the executive committee of the Continental Steel Co.

CONTRACTS AND CAPITAL

PRIVATE ENGINEERING construction awards top their respective 1939 values for the sixth successive week. The volume, $17,821,000, is 27 per cent above a year ago, but falls 14 per cent under the total for last week. Public construction is 13 and 18 per cent lower, respectively, than last year and last week.

Despite the private gain over the 1939 week, total awards are 2 per cent lower than a year ago, and they are 17 per cent below last week.



The construction volume for 1940 to date, $967,681,000, is 17 per cent lower than the volume reported for the 19-week period in 1939. Private construction, however, tops last year's total by 16 per cent.

In the classified construction groups, bridges, commercial building and large-scale private housing, public buildings, and unclassified construction gain over their respective values for the preceding week; and bridges, commercial buildings, and streets and roads exceed their totals for the 1939 week.

New capital for construction purposes for the week totals $11,298,000. This compares with $105,748,000 reported for the corresponding 1939 week. The current week's volume is made up of $6,250,000 in state and municipal bonds, $4,879,000 in USHA loans to five cities for low-cost slum-clearance projects, and $169,000 in corporate security issues.

New construction financing for the year to date, $403,193,000, is 49 per cent below the $795,330,000 reported for the 19-week period a year ago.

(*Weekly Table on page 51*)

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN APRIL, 1940

Engineering News-Record *reports projects of the following minimum costs: — water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000

Four Weeks — Thousands of Dollars (000 Omitted)

Public Works	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States April 1940	United States Four Months 1940	United States Four Months 1939	Canada
Waterworks	145	2,491	364	2,498	956	2,375	8,829	28,776	97,451	263
Sewerage	341	1,322	996	878	2,470	1,148	7,155	30,783	67,385	228
Bridges, public	183	1,632	752	673	1,137	179	4,556	34,968	58,722	137
Earthwork and waterways	831	592	4,604	5,083	2,478	1,465	15,053	61,871	53,862	.....
Streets and roads	2,185	14,243	12,079	10,699	18,035	4,048	61,289	230,625	212,962	366
Buildings, public	299	5,579	7,536	2,501	2,671	2,129	20,715	118,407	226,725	929
Unclassified, public	705	3,335	1,798	1,155	1,961	1,540	10,494	49,576	58,571	1,359
Total public	4,689	29,194	28,129	23,487	29,708	12,884	128,091	555,006	775,678	3,282
Federal government (included in above classifications)	1,489	1,156	6,311	847	1,712	3,976	15,491	92,077	74,375	.....
Private										
Bridges, private	.....	25	.....	189	39	.....	253	538	2,065	.....
Buildings, industrial	1,277	13,165	6,285	12,630	3,388	2,093	38,838	132,028	54,492	5,268
Buildings, commercial	4,110	16,966	2,615	6,240	2,820	2,090	34,841	125,865	139,542	1,530
Unclassified, private	289	3,249	1,483	570	3,378	824	9,793	41,120	70,060	5,308
Total private	5,676	33,405	10,383	19,629	9,625	5,007	83,725	299,551	266,159	12,106
Total Engineering Construction:										
April, 1940 (4 weeks)	10,365	62,599	38,512	43,116	39,333	17,891	211,816	.....	.....	15,388
March, 1940 (4 weeks)	13,338	47,457	36,208	27,596	38,067	17,170	179,836	.....	.....	5,974
April, 1939 (4 weeks)	12,436	82,084	33,838	54,322	40,673	17,382	240,735	.....	.....	5,666
Four Months — 1940	38,090	226,377	159,261	155,762	168,741	106,326	.....	854,557	.....	35,202
Four Months — 1939	64,336	345,386	148,147	191,139	195,025	97,804	.....	.....	1,041,837	21,920

Washington Highlights

(Continued from p. 54)

procedure of the bureau and the composition of its board of directors.

CONGRESS early this week passed and sent to the White House the year-old river and harbor bill authorizing $110,000,000 in navigation projects. The final form of the bill emerged from conference as a compromise between a Senate version authorizing $150,000,000 of projects (*ENR*, May 2, page 8) and an $84,000,000 House version passed a year ago. Chief difference between the bill as passed and the Senate bill was the elimination in conference of a $34,500,000 project for deepening the East River at New York City. The conference committee also eliminated $3,960,000 for the Caloosahatche River and Lake Okeechobee area in Florida and inserted a $3,700,000 navigation project on the Guadalupe River in Texas.

There is some doubt whether the bill will be signed by the President. Elimination of the New York project was a concession to the President who, in a letter to Representative Mansfield last week, said he thought the project ought not to be authorized now. However, at the same time the President reiterated his frequently expressed belief that no authorization bill is needed this year.

THE HOUSE has passed a bill extending for four years the life of the Alaskan International Highway Commission.

Groundwater Situation Still Bad

Despite above normal precipitation early this year, water situation is unsatisfactory in many areas Geological Survey reveals

Although precipitation for the country as a whole was above normal during early 1940, a large part of this was concentrated west of the Great Plains, and the water situation is still unsatisfactory in many areas. A survey of typical wells in eight scattered states made for *Engineering News-Record* by the Geological Survey reveals a very spotty picture with groundwater levels in general rather low. Only encouraging report was from Virginia where well levels have risen four feet from the low figures of last fall and are still rising rapidly. In South Carolina, on the other hand, the groundwater level, which last fall was the lowest since observations started, is still falling and there may be a serious shortage of domestic supplies in the late summer or early fall. The Long Island wells have risen slightly during 1940 and are about a foot higher than in 1932 but are still three feet below 1903 levels.

Oklahoma is worst hit

In the West, the most serious situation is in Oklahoma where the wells, very low late last year, are still dropping slowly. In Kansas, Nebraska, and Iowa there has been some recovery this year, but levels are still low.

Prospects for surface water in the West, as indicated by Department of Agriculture snow surveys are also discouraging. Only in California are ample water supplies predicted. In Arizona the water outlook is the poorest in several years, with snow cover, soil moisture, and reservoir storage all very low. In Colorado, New Mexico, and Wyoming conditions are below normal. In Idaho, Montana, Nevada, Oregon, Utah, and Washington water prospects are fair, but there may be deficiencies in areas lacking storage.

Nearly normal or better than normal precipitation in most states during the winter and early spring failed, except in the far West, to correct the deficiencies of last fall. For the six-month period ending April 1 no state east of the Rockies had normal precipitation, and precipitation in Oklahoma and North Dakota was only two-thirds of normal. In the other Great Plains states, percentages ranged from 92 in Montana to 73 in Kansas.

• • •

Arizona Engineers Continue Fight for Higher Salaries

The Arizona Section of the American Society of Civil Engineers at the section's spring meeting in Tucson April 27 passed a resolution requesting the Arizona State Highway Commission to adopt the classification and salary ranges for engineering employment in the department as recommended by Allen P. Richmond, assistant to the Secretary, Am. Soc. C.E. The resolution reads as follows: "First, adopt immediately the classification of grades incorporated in said report; second, make effective, as of July 1, 1940, the salary scales applicable to said grades which were set forth in said report; third, instruct the state engineer to determine by merit rating the grade in which each engineering employee of said department should be placed; and, fourth, adjust as promptly as possible any inequities in assignment to grade and any inequities in salary which may be found to exist."

When the resolution was submitted to the highway commission, J. M. Proctor, chairman of the commission, replied: "I know that Hutchins (state engineer) is giving this matter due consideration and will make his recommendations to the commission in due course, at which time we will no doubt act upon it."

Further details of the salary study are given in *ENR*, April 4, 1940, p. 471.

McLaughlin Air Service Photo

NEGRO LOW-COST HOUSING AT WILMINGTON, N. C.

THE HOUSING AUTHORITY of the city of Wilmington, N. C. is spending $1,058,000 for the New Brooklyn Homes to house 246 negro families. The site covers 646,000 sq.ft., including the area given over to streets. About 22 per cent of the area is used for buildings. Besides 27 two-story multiple dwelling buildings there is the heating plant, which will also serve as a community center, administration building, and a repair shop.

USHA has made available $135,000 for the work. Architects for the project are L. N. Boney, Wilmington, N. C., represented on the job by Theodore N. Ingraham. The contractor is a T. A. Loving & Co., Goldsboro, N. C.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Articulate Engineers

Sir: A renowned Boston dentist has attained his reputation by his ability at public speaking on professional topics. It would seem that this is largely a theme for the engineering schools to consider.

It is true that doctors and dentists have four years more of college training, but it is also true that most civil engineering courses omit training for political oratory.

Politicians orate and do not know the details. Engineers know the details, and could easily master the oratorical pose.

LOUIS F. BUFF
Buff & Buff Mfg. Co.
Jamaica Plain, Mass.

Length of Parabolic Curve

Sir: The discussions by Fiesenheiser and Sauer (April 13, 1939, p. 512), Magerstadt (July 20, 1939, p. 66), MacPhail (Aug. 17, 1939, p. 202), and Johnson (Oct. 2, 1939, p. 456), regarding a simplified formula for calculating the length of parabolic curves for ordinary sag ratios lead the writer to attempt to go one step further and really simplify the job. Although the equations for parabolic curve length submitted by the various authors mentioned did simplify the exact formula somewhat, they still left some sizable figures to be multiplied and divided, all of which may easily lead to a mistake, especially if you happen to be in a hurry or are figuring alone.

In going over the table submitted by Mr. Magerstadt, giving the exact parabolic curve lengths for half spans of 2,000 ft. with various sags, it occurred to the writer that the correction for parabolic curve length could be set up in the form of a graph with the correction plotted as ordinates of a curve based on the sag ratio for a ½ span of 2,000 ft. and then made proportional to the span ratio for any other span length having a sag ratio covered by the curve in the chart. Since a sag of 400 ft. in a ½ span of 2,000 ft., or for the full span of 4,000 ft., is not an extreme case, as was stated in the previous discussions, the chart was extended to include sags up to 12 per cent, which pretty well covers the normal sag ratios.

While the chart is not mathematically exact, it does give results which are well within the degree of accuracy usually obtainable in the field and fully as close as those obtained by the approximate formulas. The example given in the chart is taken from an actual structure coming under the writer's personal supervision, and the curve length as obtained from the chart varies only about 0.06 ft. from that given by exact formula.

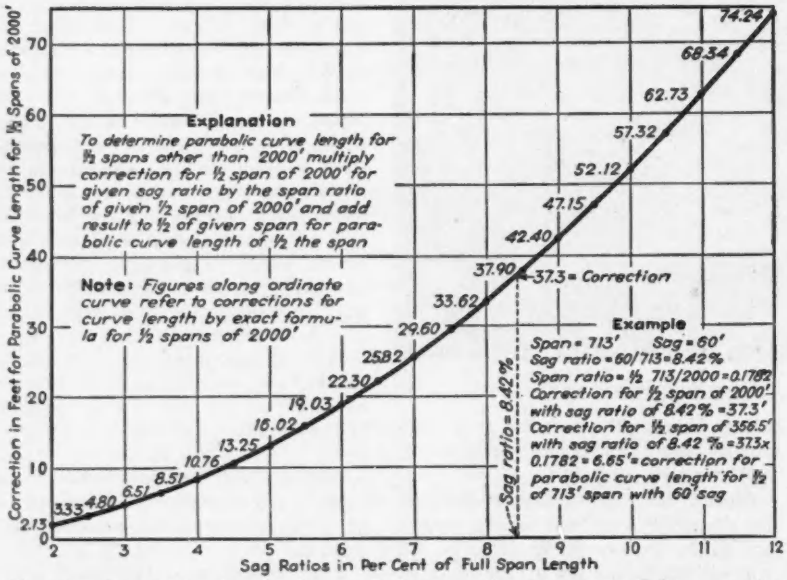

Correction in Feet for Parabolic Curve Length for ½ Spans of 2000'
Sag Ratios in Per Cent of Full Span Length
Explanation
To determine parabolic curve length for ½ spans other than 2000' multiply correction for ½ span of 2000' for given sag ratio by the span ratio of given ½ span of 2000' and add result to ½ of given span for parabolic curve length of ½ the span
Note: Figures along ordinate curve refer to corrections for curve length by exact formula for ½ spans of 2000'
Example
Span = 713' Sag = 60'
Sag ratio = 60/713 = 8.42%
Span ratio = ½ 713/2000 = 0.1782
Correction for ½ span of 2000' with sag ratio of 8.42% = 37.3'
Correction for ½ span of 356.5' with sag ratio of 8.42% = 37.3 x 0.1782 = 6.65' = correction for parabolic curve length for ½ of 713' span with 60' sag
Sag ratio = 8.42%
37.3 = Correction
2.13
3.33
4.80
6.51
8.51
10.76
13.25
16.02
19.03
22.30
25.82
29.60
33.62
37.90
42.40
47.15
52.12
57.32
62.73
68.34
74.24

Chart for determining length of a parabolic curve for any span and for sag ratios up to 12 per cent.

A. TIGGELBECK
Consulting Engineer,
Sandpoint, Idaho

Salt on Concrete Pavement

Sir: In *Engineering News-Record* of April 11, p. 503, is published an article entitled "Salt Breaks Ice Bond."

As the result of flaking, spalling, and disintegration of concrete surfaces due to application of rock salt in icy weather the use of rock salt is forbidden in New York City by the Triborough Bridge Authority, the Department of Public Works and the Department of Borough Works of Manhattan, on any of the concrete surface highways under their control. Evidence of injury to concrete surfaces by rock salt applications is plentiful. The Portland Cement Association has conducted research into this problem and has information which may be obtained on application.

Perhaps the author does not refer to ice on concrete pavements, but the illustration certainly looks like concrete and no statement to the contrary is made in the article.

If the Sullivan County roads on which the rock salt was applied have a concrete surface of recent date it would be interesting to learn what the concrete surface looks like now that the ice and snow are gone.

DEAN G. EDWARDS
Consulting Engineer, Office of the President of the Borough of Manhattan

Paving at Intersections

Sir: In the Jan. 18 issue, Robert F. Aluise, in commenting upon my article entitled "Paving Areas at Intersections" (*ENR*, Nov. 23, 1939, p. 711), stated that the table is satisfactory for skews of even degrees, but for angles with minutes and sec-

onds it is necessary to use the formulas for A_1, A_2 and A_3.

I cannot agree with Mr. Aluise's statement. The table was constructed so that interpolation is possible without a loss of accuracy out of line with the inaccuracies introduced in the field even with the best engineering supervision of competent workmen.

To be sure, slight inaccuracies will enter into the computing of the area A_1 when the skew angle becomes great. The maximum error of interpolation will occur at a skew angle of 74 deg. 30 min. However, at 74 deg. 30 min. the error is only 0.13 per cent, and becomes smaller as the angle approaches 74 deg. or 75 deg. At 49 deg. 30 min., the error of interpolation is only 0.021 per cent, and can surely be neglected. If greater accuracy is desired near 75 deg., this can be obtained by computing the constant K_1 to 30-min. intervals for angles from 60 deg. to 75 deg.

One pertinent criticism that Mr. Aluise overlooked involved the formula for computing A_3. For small angles, if R_2 is large as compared to R_1, then it is possible that the area A_3 is dependent upon R_2 instead of R_1. In that case the formula for computing area A_3 becomes

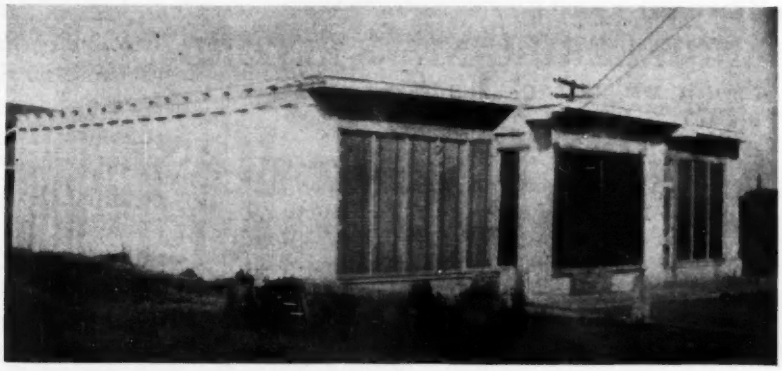
$$A_3 = \frac{W}{9}\left[R_2 \tan\frac{90^\circ - \theta}{2} - \frac{W}{2}\tan\theta\right]$$

VERLIN M. WANN
U. S. Geological Survey
Indianapolis, Ind.

Compressed Concrete

Sir: The article (*ENR*, March 28, 1940, p. 452) on the German bridge girders of prestressed (or compressed) concrete prompts me to describe a method I have used. Instead of pouring the concrete around steel already stressed, this method involves preventing early bond by means of coating the steel with some suitable material, pouring the concrete around it, and then stressing the steel against the body of the concrete, usually by means of nuts on the exposed threaded ends of the reinforcing. I have used it to produce slabs to build the house shown in the accompanying illustration.

The slabs for the roof and for the ceiling of the largest room are 14 ft. long by 2 ft. wide with a 4-in. flange running entirely around each slab. The web is 1 in. thick. These slabs were all precast in metal forms and cured two weeks or more before use. The reinforcing consists of a ½-in. rod in each of the 14-ft. flanges and a 10-gage wire in each of the short flanges.



House made of precast slabs of compressed concrete.

Slabs 12 ft. long by 2 ft. wide with a 2¾-in. flange and a ⅜-in. rod in each long flange were used for outer and inner walls, partitions, and ceilings.

During the setting and shrinking of the concrete, the rods were stressed more and more against the concrete. The result is similar to that obtained by prestressing the steel, with this additional gain: there is no loss of about 20,000 lb. per sq. in. of tension in the steel due to shrinkage and plastic flow. Whether the steel is stressed before or after the concrete has set, however, the principal tension stresses in the concrete are changed to compression.

The writer has lived in the house since August, 1936, and found it satisfactory. A noteworthy fact is that not one of the 55 slabs used in the roof has developed a leak. No waterproofing preparation was used, but considerable care was exercised in consolidating and curing the concrete.

R. E. DILL
Alexandria, Neb.

Misleading Pile Tests?

Sir: Referring to the article on "Novel Pile Test Loading" in *ENR*, Feb. 1, 1940, p. 183, it appears to the writer that the results of pile tests by this method are erroneous, the degree of error depending on the nature of the soil into which the piles are driven. The upward forces in the soil surrounding the anchor piles are transmitted to the test pile. The downward forces in the soil surrounding the test pile are, in turn, transmitted to the anchor piles. For these reasons the downward loads on the test piles are, to a degree, dependent on the soil, supported by the upward loads of the anchor piles. Likewise the upward loads on the anchor piles are, to a degree, dependent on the soil, supported by the downward loads on the test piles.

Resulting loads on the soil below the three piles in question must be zero. For these reasons, the results obtained by this method of testing are, in the writer's opinion, very misleading as a basis for determining the load-carrying capacity of the piles.

Description of a similar test was published in the *Wood Preserving News*, March, 1940, p. 32. In this case the only difference was that the piles were tested for their resistance to uplift, and the jacks were placed directly on the ground adjacent to the test pile. Here again, the results obtained by the method shown will be entirely misleading for the same reason as stated above.

INGOLF ERDAL
Hazelet & Erdal
Consulting Engineers
Chicago, Ill.

Keeping the Record Straight

For those who were confused by the lack of clarity in one paragraph of Farley Gannett's article in our issue of April 25, it should be stated that in the second paragraph of the second column, p. 577, the second sentence should read, "Filtration, which was then relatively new in waterworks engineering in the United States, was attracting wide attention."

In replacing battered type in this page the lines were incorrectly replaced and the error was not caught by the proofreader in the printshop.

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May 9, 1940

CONGRESS was given a chance last week to vote on a good federal aid highway bill. The House roads committee did a constructive job in returning the authorizations to the 1936 level and in making possible RFC loans for right-of-way. This latter provision, a new one, is a start, at least, toward solution of the expensive city entrance road problem, and the increased money will enable the states more nearly to keep up with traffic requirements. To insure early consideration of the bill, the House rules committee will have to make a special ruling. It should turn on the green light without delay.

Fast Tunneling

INTELLIGENT USE of equipment and coordination of methods have speeded up every type of construction, but in no field has progress been so startling as in tunneling. Driving records, inconsistent as they may be because of varying local conditions, have been broken repeatedly in the last few months, with New York's Delaware Aqueduct and Colorado's Carlton drainage tunnel competing in setting a faster and faster pace. First it is 56 ft. per day for 31 days in hard granite, then 60 ft. per day in material that requires some timbering, next 69 ft. per day in the granite. And so it goes, with shield driving in the Chicago subway threatening to set new standards for still another type of work. In all cases a combination of engineering brains, construction ability, and dependable, efficient equipment has made the remarkable progress possible and earned congratulations for tunnel engineers, constructors and equipment manufacturers.

The Price of Progress

PREMONITION of the reconstruction that faces many of the tall buildings that made Chicago famous in the closing decade of the last century is had in the demolition of the Great Northern Hotel, described in this issue. No weakness of skeleton, no deterioration of its flesh and integument of brick and tile has in fifty years made this structure a risk, but now the modern subway promises to alter the once satisfactory foundation conditions. Like most tall buildings of its era its loads are footed on broad grillages on the plastic upper clays of underground Chicago. With street occupancy for passenger subways, old conditions of upper clay equilibrium are changed, and foundation bearing values are disturbed. At the Great Northern Hotel this required costly new foundation work that made the old building not worth preserving. A similar alternative confronts owners of other tall buildings of Chicago's early skyscraper era. Thus, the swelling flood of traffic brings changes quite aside from the more obvious one of street widening. If progress seems to penalize these old buildings, it can only be recalled that it has ever been thus. The price of progress is not an idle phrase.

Highway Surfacing for Levees

EXPERIMENTS in slope protection now being conducted on the levees of Lake Okeechobee show clearly how research in one field may prove to be beneficial in an entirely different field. Heretofore, slope protection research has been pointed toward the Mississippi River where the erosive effect of swift water must be resisted over long periods of time, requiring heavy mats and paving. On Lake Okeechobee quite different conditions prevail. There the more frequent attacks are from normal storms, and the most severe will be from hurricanes of comparatively short duration. Sensing that less costly revetment than that used on the Mississippi might do, the engineers turned to the experiments of highway engineers in developing surfacing for light traffic roads. Soil-cement mixtures and road mix asphalt appeared to offer possibilities, and they have been applied to test sections as described in this issue. The finished product has high promise and, as costs have been cut to less than one-third the cost of sheet asphalt, the highway engineers' research seems destined to pay good dividends on levee construction.

Look to the Future

THE SUPREME COURT DECISION declaring illegal San Francisco's sale of Hetch Hetchy power to the Pacific Gas & Electric Co. for resale to consumers closes the record so far as the past is concerned. Without question San Francisco had

been ignoring clear prohibitions in the Raker Act, but whether or not it had justification for doing so on the ground that Congress overstepped its authority is now of no moment. What is important is to consider the effect of the Supreme Court decision on conditions as they exist in the city today. As the law stands, San Francisco must build a duplicate distribution system or must buy the present one and build or buy the power plants needed to meet the power load of the city. No one knows whether that will produce an efficient power system, nor is it known whether such a great expenditure will cripple all other municipal services and lower their efficiency for years to come. Congress might well study these questions. If the result is a clear showing of lost efficiency, the act requiring public sale of Hetch Hetchy power should be amended. The principle that the public alone should profit from the use of public land can still be maintained.

Waterworks Code

HIGHLIGHT of the American Water Works Association Convention in Kansas City was the address of Paul V. McNutt, administrator of the newly established Federal Security Agency, in which he stated that a code of waterworks practice was in the making. This advance information, plus a personal appeal by the administrator for cooperation in drafting such a code, gives to the association a new opportunity to extend its usefulness by coordinating the resources of professional and industrial interests in waterworks service.

Details concerning the new federal regulation of water quality and standards are not available. However, it is known that they will widen the scope of regulations first promulgated in 1914 and revised in 1925, which deal with the sanitary control of drinking water furnished to interstate carriers. It will be recalled that these standards established by the U. S. Public Health Service became the accepted standards for all water purveyors, regardless of their service to interstate carriers. Therefore, it can be assumed that the new regulations will likewise be nation-wide in their effect.

If the Kansas City meeting offered nothing else, the public announcement of pending regulations was good and sufficient cause for assembly. The waterworks industry not only has been properly informed, but also received a formal invitation to participate in a vital piece of work. Cooperative action of this kind should produce a code of maximum usefulness.

Peace on the Border

IN THESE DAYS of large undertakings a $50,000,000 canal project is not particularly unusual. But the canal project now before Congress and (as described this week) designed to protect the lower Rio Grande Valley against water famine, is significant for other reasons than size. Its importance will be appreciated by all who remember the dramatic story of border warfare for water told by W. W. DeBerard in our issue of Nov. 3, 1938.

The sharp rivalry for the river's waters, which was in full swing two years ago, is about to be intensified with the beginning of large-scale irrigation in the Matamoros area of Mexico. The possibility that the entire summer flow may be tapped off into Mexico through the Retamal headgate is a deadly threat to the American delta farmers. Construction of an upstream intake into an American canal to supply their lands would remove this threat and would hasten the day when international agreement will provide for conservation and equitable division of Rio Grande waters.

Further growth of irrigation in the warm, fertile delta region is certain. Coupled with variation in streamflow that in recent years has frequently left the river dry at the pumping plants and forced the people to bring in drinking water long distances by tank car, it presages growing bitterness between the rival claimants to the water. The canal project can end this antagonism, and so help to bring peace on the border.

The national interest argues for early authorization of the project and justifies the view that part of its cost should be a national charge. How much the nation should pay and how much the directly benefited landowners is a matter that should be decided on sound principle, however. The proposed allocation of nearly three-fourths of the cost to the federal government appears to make insufficient allowance for the magnitude of the local benefits, estimated at well above $100,000,000. The cost allocation should be in harmony with the equities, with general practices of irrigation repayment, and with the doctrine of fair reimbursement for the cost of public facilities that make natural resources available for private benefits.

FIG. 1. ENLARGING THE LAKE OKEECHOBEE LEVEES WITH ROCK DREDGED FROM THE LAKE BOTTOM.

Larger Levees for Lake Okeechobee

Contents in Brief — Enlargement and strengthening of the levees around Lake Okeechobee in Florida now is in progress using shell conglomerate and limestone rock dredged from the lake bottom. New methods of levee construction are described and experiments in protecting slopes against erosion are outlined.

FOURTEEN MILES OF LEVEE along the southeast side of Lake Okeechobee in Florida are being enlarged and reinforced to insure their stability during hurricanes and bad storms and to give greater protection to the communities south and east of the lake.

Lake Okeechokee lies at the north end of the Everglades in southern Florida. Most of its south and eastern shore, originally, was but a low sand ridge over which water from the lake flowed into the Everglades during time of high water.

Because of the fertility of the soil, concerted efforts were made early in the century to drain the Everglades and open them up to development. Between 1913 and 1926 local agencies spent $18,000,000 on drainage canals, locks, levees and pumping plants, and by 1926 there were several communities and much land development along the shores of Lake Okeechobee.

Lake Okeechobee has a drainage of about 4,500 square miles and an annual rainfall of from 45 to 60 in. Originally the lake had no direct outlet to the sea and its level ranged from an extreme low of El. 12 to El. 21, the normal range being between El. 15 and 18. In the drainage work, small canals with controlled spillways at the lake were built out through the Everglades to the ocean, some having small locks to facilitate navigation. These canals gave some relief in time of flood but were inadequate for proper control of the lake level, which normally is high at the hurricane season.

Fig. 2. Lake Okeechobee lies at the northern side of the Everglades region of southern Florida.

In 1926 and again in 1928 hurricanes swept storm tides over the low shores of the lake causing much damage to property and the loss of about 3,000 lives.

As a result of these disasters the federal government, in 1930, inaugurated a flood control program that included the construction of 83 miles of levee, six hurricane gates at the canal outlets and enlargement of some of the canals to increase their capacity. That work was begun in 1930 and was substantially completed in 1937. Initially, the levees were built largely by draglines throwing up into the levees such material as could be obtained from borrowpits along the line of the levees, including sand, shell, marl and limestone rock of varying degrees of hardness. Subsequently the construction methods were modified to permit the inclusion of hydraulically placed material. Because the sand ridge along the lake shore was largely occupied by houses and roads, the levee was thrown up on the lake side. Trenches were cut through the muck at the toes and filled with rock or other coarse material, but no effort was made to remove the muck from in under the

levee prism. Rock also was placed along the toe on the lake side to protect it from wave action.

For the levee work begun in 1930, the top was made 10 ft. wide at El. 31; subsequently the level of the top was raised to El. 34 on most of the levees and to El. 36 around South Bay where storm tides pile up. The highest recorded storm tide and waves reached El. 29.6. Levee slopes were made 1 on 4 on the land side and 1 on 6 on the lake side down to a 30-ft. berm near high water level. (For fuller details of the earlier work see *ENR*, Aug. 16, 1934, p. 195, and July 18, 1935, p. 81).

Soon after the first of the levees had been completed seasonal storms began to attack the toe of the bank, scattering the rip rap and cutting far back into the levee. At the same time, compaction of the underlying material resulted in a lowering of the crest in some regions below that deemed safe in time of hurricane.

In the current enlargement work the crest of the levee is being raised from El. 34 to El. 36 for about 7½ miles, and from El. 31 to El. 34 for the remainder of the section under improvement. The top width is being increased from 10 ft. to 20 ft.; the lakeside slope is made 1 on 6 down to El. 23 (the point of worst attack in normal storms) and below that point the slope is flattened to about 1 on 20 to form a beach on which waves will break and dissipate their energy. Specifications require that 80 per cent of the material placed in the levee shall be rock and that 22 per cent shall be retained on 1½-in.-square mesh. Actually, the percentage of rock has been around 90, and the retained material is around 32 per cent.

Method of construction

Two 20-in. suction dredges, the *Welatka* of the U. S. Engineer Department and the *General* of the Arundel Corp., and four drill boats are being used for the current work. At the start it was believed that a large part of the rock could be dredged without drilling and shooting, using a type of cutter head developed by the Atlantic Gulf Pacific Co. for work in soft rock, but experience soon showed that shooting the rock was necessary and that is being done regularly now. For the work of the U.S.E.D., 6-in. holes are drilled on 8-ft. centers between holes and between rows across the 200-ft. face of the borrowpit and are shot with charges of 3x8-in. sticks of 50 per cent dynamite placed with a special charging tool developed for the work. At present, plans are being made to try "Nitramon S." recently developed by duPont for seismic exploration, because of the lesser risk involved in handling that material on drill boats. Through constant study of drilling methods, the cost of blasting for the U.S.E.D. work has been cut to around 10c. per cu.yd. The U.S.E.D. drill boats are equipped with 6-in. steam drills having star bits with a 1-in. hole in the center through which a water jet of 150-lb. pressure can be operated to clean out the holes. Arundel uses 3 and 3½-in. air drills with 4-in. bits, with the blasting arrangements modified accordingly, otherwise the dredging operations are similar.

Generally, the conditions in the borrowpit areas are these: 10 to 14 ft. of water, 3 to 7 ft. of overburden, sand, muck, etc., and from 10 to 13 ft. of rock of varying degrees of hardness overlying marl or other soft material. In drilling, a sand pipe somewhat larger than the drill bit is sunk through the overburden to rock. This keeps out sand or muck from the overlying material while placing the dynamite. However, as the rock frequently is stratified with layers of soft material, the task of keeping sand and other material out of the holes often is not as simple as that statement sounds and difficulty frequently is experienced in loading the dynamite into the holes.

After the rock is shot the dredge moves forward, swinging its cutter head along the low edge of the rock face. This drops the shattered rock from the face around the suction intake and at the same time lets the overburden slide back over the fallen rock into the excavated area where only a small amount is picked up by the dredge. The rock, which is a limestone containing a large amount of shell, breaks down into pieces ranging from those just large enough to go through the cutter to material best characterized as coarse sand.

In the prosecution of this work, the U. S. dredge *Welatka* has pumped approximately 3,250,000 cu.yd. of material consisting of a very high percentage of rock, nearly 90 per cent, and has averaged better than

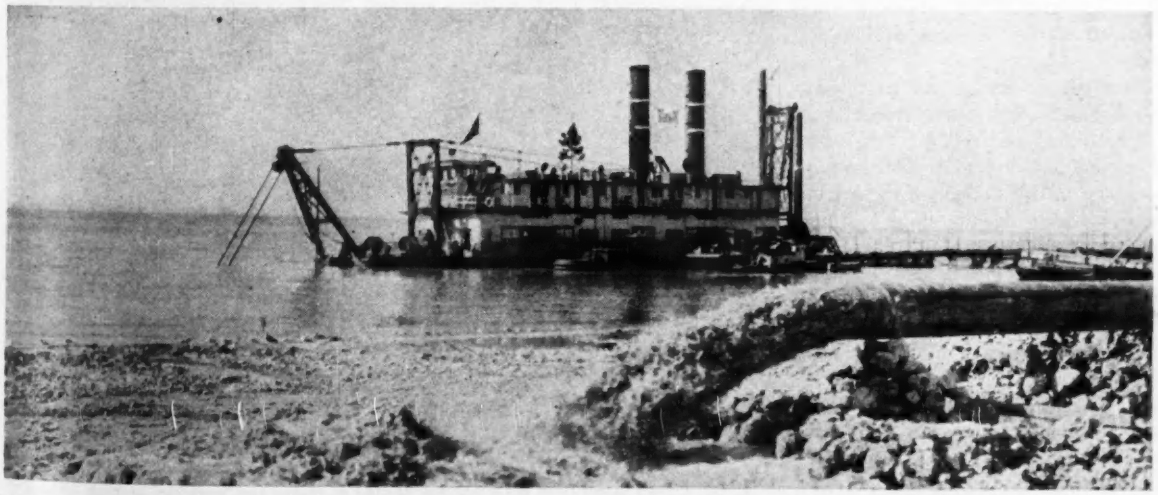


Fig. 3. Dredge *Welatka* pumping rock from an offshore borrowpit into the levees. The discharge line runs first to the top of the levees, as shown in Fig. 1, and then drops back to near the shore where the layer rocks are deposited, as here shown.

Fig. 4. Bleeders on the bottom of the pipeline and baffle boards on the slope are used to distribute the dredged material.

480 cu.yd. of material per pumping hour. On similar work the dredge *General* has averaged in one month about 625 cu.yd. per pumping hour.

All new material is being placed on the top and lake side of the levee. That going into the part above water is pumped through pipe lines extending up to a trestle along the top of the levee, as shown in Fig. 1. Controlled openings in the bottom of this pipeline and baffles on the slope below make it possible to get a well-balanced fill at all points. The outer end of the pipeline is run back down to the water's edge where the largest stones are sluiced out. This places them at the point of major attack by the normal storms.

Two sets of pipes and trestles are used, one being taken down and advanced while the other is in service.

After the hydraulic fill has been placed it is bladed to the proper section, sprinkled and rolled. This produces what amounts to a water-bound macadam on the surface of the levee.

Below water, the flat slope is built up of small rock, sand and other material rejected from the main levee, material that will be stable on a slope as flat as 1 on 20.

When work was commenced in the fall of 1938, costs on the U. S. Engineer Department work were $0.41 per cu.yd. taken from the borrowpit and $0.49 per cu.yd. in the levee, the difference being due to wasted material from the pits. Since then, through improved methods of drilling and blasting and through a reduction in the borrowpit width to 200 ft. or less, depending on rock depths, the costs have been cut to $0.31 and 0.34 respectively. This reduced the cost per linear foot of levee from $46.53 to $29.23.

Surfacing experiments

An interesting set of experiments with several types of surfacing for the exposed face of the new levees has just been completed. In all cases the treated surface begins two feet down from the crest on the land side of the levee, extends across the crest and down the 1 on 6 and 1 and 20 slope to the water's edge.

The first section is 2,000 ft. long, a soil-cement mixture in which 7 per cent by volume of cement was added to the top 6 in. of the surface by working it in with cultivators, harrows and blade graders, after which the processed material (rock, marl, sand, shell and cement) was compacted with sheepsfoot rollers. The whole was then rolled with a smooth wheel roller and covered with moist material from other parts of the fill to permit curing. Subsequently, the covering material was taken off with a road grader. In making the mix, all stones over 3 in. in diameter were picked out and discarded. The resulting mixture of small stones, rock particles and sand had a natural grading of high density. Consequently, the finished product has a fairly high crushing strength.

This soil-cement surfacing cost about 52c. per sq.yd.

Adjoining the soil-cement section are two short (150-ft.) sections of 3-in. asphalt paving. In one section a wire mesh (8-in. squares) is embedded at the center and in the other cotton fabric is embedded. In the construction of both, a 1½-in. layer of fine mix asphalt (aggregate passing ¼-in. mesh) was laid on the grad-

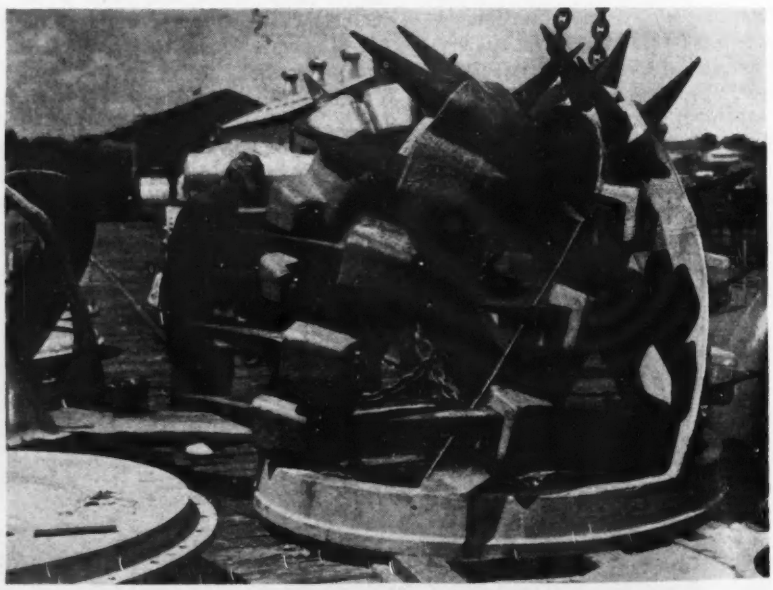


Fig. 6. Cutter head now used on the dredge *Welatka* for working in rock in Lake Okeechobee. It is of the "reverse helix" type developed by the Atlantic Gulf & Pacific Co. as an improvement over the type shown at the left.

ed slope, then the mesh or cotton was laid on and the second 1½-in. sheet of asphalt was placed.

The cotton-reinforced pavement design was developed by John D. Drury, Melrose, Mass.

The reinforced sheet asphalt costs $1.74 per sq. yd. with wire mesh, and $1.83 with cotton cloth.

A fourth test section is a half mile of road-mix asphalt. It has a nominal thickness of 2 in. but actually ranges between 3 and 4 in. Specifications called for 0.625 gal. of MC2 cutback asphalt oil per inch of depth per square yard. The seal coat varies from 0.25 to 0.30 gal. per sq.yd. Best results appear to have been obtained when using RC3 for the seal coat. The seal coat was given a ¼-in. cover of sand.

Large stones in the fill proved to be detrimental to the success of the road-mix job. They crushed under the rolling and produced fines that were not impregnated with asphalt. This surfacing cost $0.47 per sq.yd., or substantially the same as the soil-cement work.

The final test section of any considerable size is one in which a 6-in. layer of marl dredged from the lake bottom was bladed and rolled over the rockfill. Marl was tried as a surfacing material on the basis of experience with marl fills for the old railroad line over the Florida Keys. There, marl exposed to the sun and air has baked into a hard shell that stands up well under wave action. The Okeechobee work, however, gives little promise of being a success.

Two small test sections of penetration macadam have been put down.

The levee work on Lake Okeechobee is being carried out under the general direction of the U. S. Engineer Office at Jacksonville, Col. Lewis H. Watkins, district engineer. Field work is in charge of Carawan Nelson, senior engineer, with A. R. Broadfoot, associate engineer, and George T. Augur, assistant engineer, as principal assistants of the subdistrict office at Clewiston.

The Belcher Oil Co. of Miami, Fla., was contractor for the mixed-in-place asphalt project. The John E. Ballenger Construction Co. of Lakeland, Fla., was the contractor for both types of reinforced asphalt paving and Norman Rockey Latham of West Palm Beach, Florida, was the contractor for the construction of the soil-cement section.

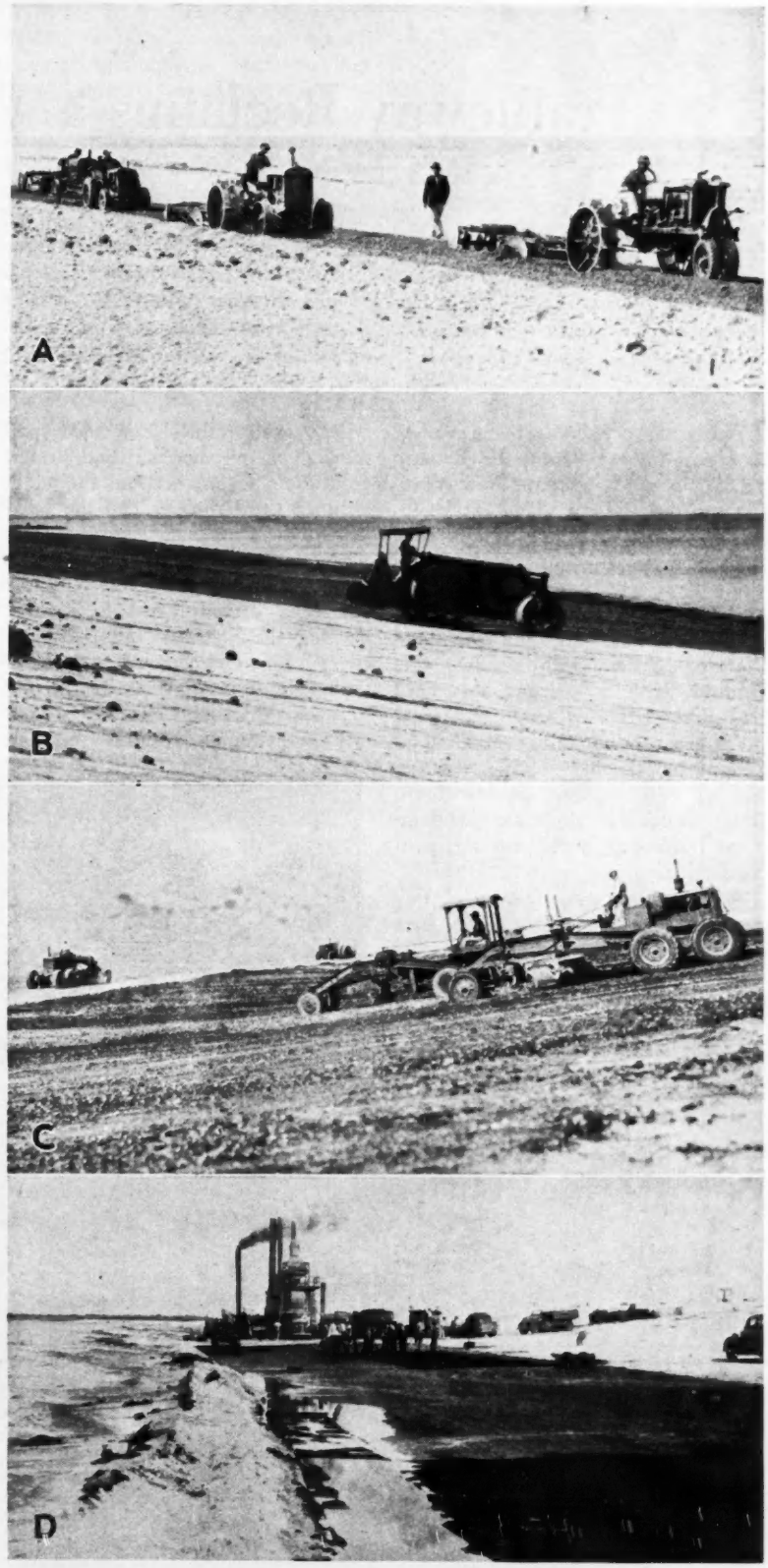


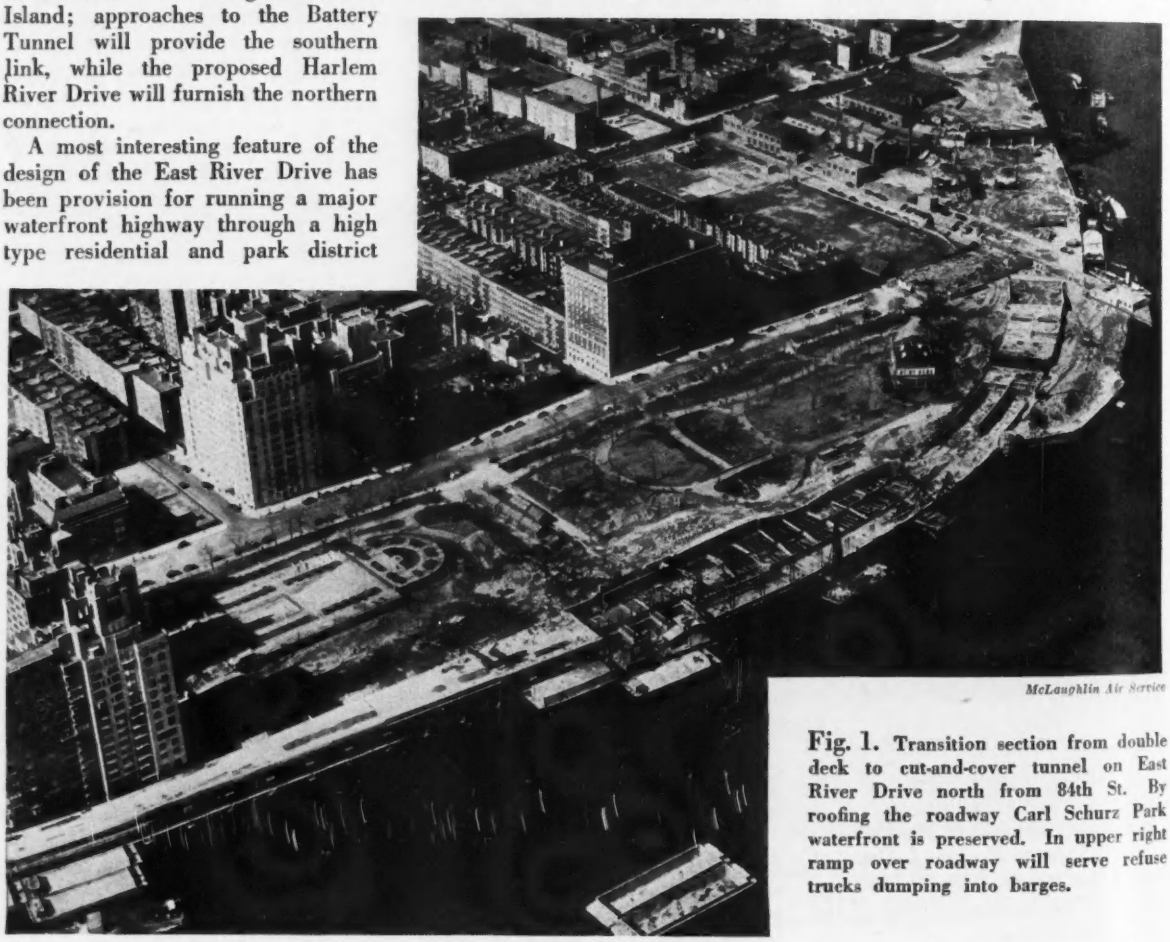
Fig. 5. Experimental surfacing on the levees. (A) Dry processing the soil-cement sides. (B) Roller working on the marl surfaced area. (C) Blade graders mixing asphalt oil into the section given a mixed-in-place road surface. (D) Laying the first section of the cotton reinforced asphalt surface along the toe of the levee.

Trafficway Reclaims a Waterfront

Contents in Brief—Riverside thoroughfares are gradually encircling the island of Manhattan. Newest link, now under construction, is along East River from the Battery to Triboro Bridge. Featured in the design are provisions for maintaining waterfront residential and commercial values, accomplished in two sections by double decking and by roofing the roadway where shoreline right-of-way is narrow.

DESIGNED eventually to be a non-stop highway from the Battery at the tip of Manhattan, New York City, to the Triboro Bridge at 125th St., a distance of 9 miles, major sections of a new 6-lane road along the East River are under construction and will be completed in the early summer. Companion to the West Side Elevated Express Highway along the Hudson River waterfront, this new East River Drive will become a part of a belt-line encircling Manhattan Island; approaches to the Battery Tunnel will provide the southern link, while the proposed Harlem River Drive will furnish the northern connection.

A most interesting feature of the design of the East River Drive has been provision for running a major waterfront highway through a high type residential and park district where land values depended primarily on an unobstructed waterfront view. In two sections the width between the buildings and the bulkhead line is not sufficient to accommodate all traffic lanes at one level. Preservation of the exclusive area has been accomplished by double decking the highway and putting a cover over the upper deck to form an esplanade or addition to private grounds. One short section of cut-and-cover tunnel restores the natural ground at an historic point. In all cases the design made provision for retention of commercial waterfront facilities and taxable values of residential riparian property. Easements rather than outright title have generally been taken. In one instance a finished cover over the double-deck roadway, ready for landscaping, was exchanged for passage along the river. In another, riparian owners paid the cost of the cover to increase their own area and to preserve the privacy of the property. In other places filled-in and reclaimed areas were bartered for the required easement, the city feeling that land gained in this way and added to the tax rolls is a profitable investment instead of an expense; at the same



McLaughlin Air Service

Fig. 1. Transition section from double deck to cut-and-cover tunnel on East River Drive north from 84th St. By roofing the roadway Carl Schurz Park waterfront is preserved. In upper right ramp over roadway will serve refuse trucks dumping into barges.

time the city recognizes that accretion on riparian lands goes to the waterfront owner. Generally, ends of intersecting streets and other public property have been made into parks.

At present the drive starts at Montgomery St., about 1½ miles from the Battery. North from Montgomery to 30th St. the drive will be at surface elevation except at an access point to a park where motor traffic dips to permit pedestrian travel at grade. A part of this section is already in service as a 6-lane divided highway, though some temporary bottlenecks exist and it cannot be operated without lights until service drives are added to carry local traffic. A new bulkhead and marginal street were required in the 23rd to 30th St. area. Construction included a considerable increment of land at Bellevue Hospital, which it is expected will be used for additional hospital grounds in the form of landscaped areas.

The section from 30th to 49th St. is now in the design stage, money for its construction being included in the 1940 budget. This section is a true marginal way with its waterfront reserved for industrial use. It is planned ultimately to have an elevated steel highway from 30th St. to 38th St. with necessary ramps to be outside these points. The road will then be at ground level from 41st to 46th St. where it again rises over the roof of the proposed Lehigh Valley R. R. freight station, this rise being used also for the on and off ramps on 48th and 47th St. respectively. Only construction of the northerly elevated structure is contemplated at this time as much of the traffic is expected to leave the highway in the midtown section, making a few grade access roads permissible in this area. Direct connection to the Queens Midtown Tunnel at 38th St. is not provided.

On and off ramps are provided where indicated in Fig. 2. In general these ramps will be short simple structures taking advantage of varying elevations of ground and roadway to avoid crossings at grade.

Major construction is now in progress from 49th to 93rd St. At 49th St. the drive is quite a distance outshore leaving an area to be filled. The filled area tapers to the bulkhead line near 54th St. leaving only a narrow passage. As a condition to receiving a permit from the Army Engineers to construct a bulkhead along the U. S. pierhead line north of 49th St. the city was required to excavate an amount equal to the cross-section of the encroachment to maintain the same rate of tidal flow in the channel. At this point the drive is double-decked, the inside, southbound three-lane roadway going over the northbound. Open construction permits both roadways to have waterfront view, light and air. Typical design in this area is shown in Fig. 4. Original design called for an all reinforced concrete structure, the single concrete columns of which would have been large and have given the structure a massive appearance. The adopted design of twin steel columns and encased girders gives a much lighter and more pleasing appearance. The double steel columns are each to be covered with a gray aluminum shell filled with concrete. The rear wall in multiple deck sections is a combination retaining and supporting wall. It gives the necessary lateral stability to permit use of the light riverside columns.

Fig. 5 (b) shows rock line and old waterfront profile with the new structure at 57th St. Note that the two 32-ft. roadways are in transition from double deck to parallel lanes. The lower and middle decks for motor traffic and the roof for landscaping or esplanade are 27-in. slabs of reinforced concrete with wearing course placed integrally. A pair of columns 12-in. 100-lb. or heavier) resting on the pier carry a 72-in. plate girder which supports the riverside reaction of the slab forming the middle deck. Roof or upper deck is carried on a concrete girder supported by the same columns. In transition sections heavy wide flange beams span the 35-ft. opening for the lower roadway to pick up the girders of the middle deck. Columns supporting the roof or in the transition sections are generally spaced closer than the usual 45 ft. for piers and outside walls, but the double columns are retained at the ends of spans.

Supports shown are typical for this section of the drive, though varying rock elevations require different treatment. Piles, where used, are 18-in. inside diameter ½-in. wall, closed-end steel shells driven to rock and filled with concrete. Much of this section is supported on footings or walls placed in open cofferdams, as the rock is relatively high. In a few cases the Montee caisson method was

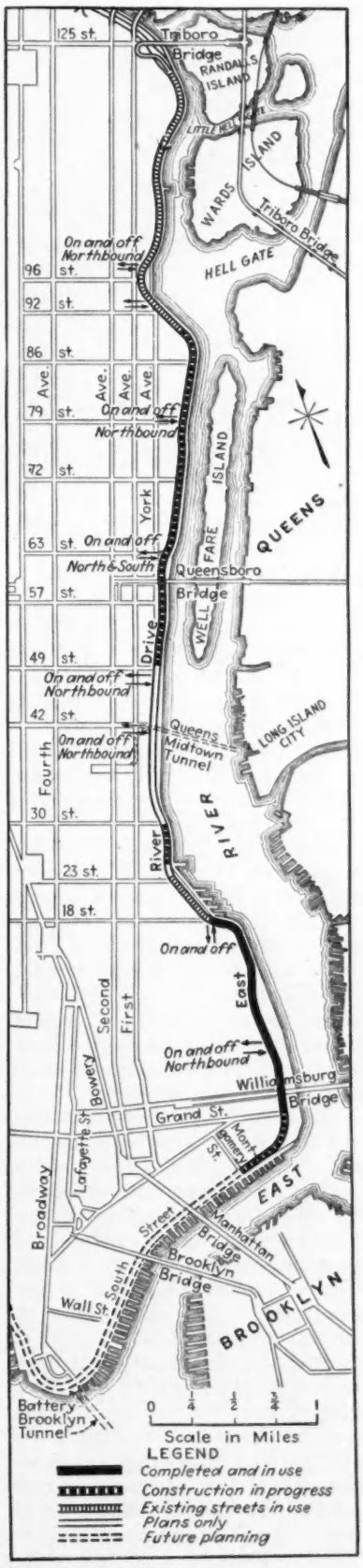


Fig. 2. Manhattan's East River Drive.

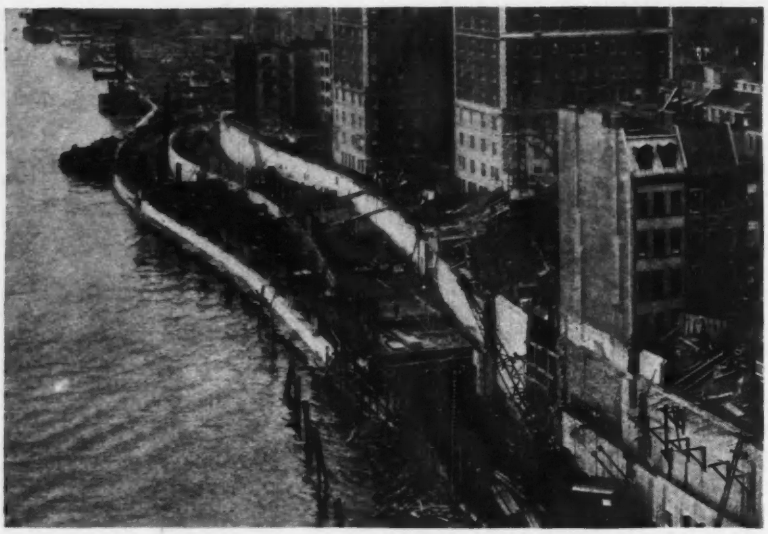


Fig. 3. Historic Sutton Place, about 56th St., retains its waterfront as drive becomes double-decked and roofed in narrow section.

used. This is a large diameter cutting shell with tight top which is rotated to cut its way to rock. Water pressure inside forces soupy material out and up from the bottom to lubricate the cutter. When rock is reached the shell is cleaned out with a digging bucket and the caisson shell withdrawn as concrete is placed to form the pier.

Near 59th St. the right-of-way widens on a fill out to the bulkhead line, and the drive returns to ground level. To take the utmost advantage of the available area a bulkhead wall as shown in Fig. 5(c) was constructed. Deep-lying rock made piling necessary, and long treated timber piles were driven with a sheetpile retaining barrier along the inside edge of the bulkhead structure. Sandfill, required to the low water line, was brought in by a self-propelled and self-unloading sand sucker dredge. Riprap was required outside the sheetpiling to assist in equalizing the pressure on the bulkhead and to stabilize the unsupported length of timber piling. Widening at this point made land available for commercial purposes, and the type of construction permitted 35-ft. minimum depth of water at the dock. This widened and filled area continues to 63rd St. From there to 79th St. the new drive utilizes the waterfront Marie Curie Ave., short sections temporarily providing only two lanes of traffic in each direction.

From 79th St. north the drive again becomes double decked to follow a narrow right-of-way riverward of certain private property and Carl Schurz Park. The drive is covered over to maintain the waterfront of the park and in one section an extra deck is added to provide a playground for a school. Fig. 5(a) shows a section through the drive structure in this vicinity and Fig. 5(d) a detail of the riverside pier and wall. The foundations are a series of small sheetpile cofferdams driven to rock, cleaned out, leveled, and filled with concrete. The riverside piers are granite faced to El.-5.0, the low tide range.

From 86th St. the north and south lanes are again at the same level and pass through a cut-and-cover tunnel section to preserve the slope of land through the historic Gracie Mansion section of the park. Vehicles, at a speed of 35 mph, will pass through the tunnel in 8 seconds. Provision is made for automatic forced ventilation when required.

At 91st St. an existing waterfront city-owned asphalt plant will be abandoned and a modern plant built, with dust and noise elimination devices and an architectural appearance that will be in keeping with the residential surroundings. Lack of commercial waterfront in the area makes maintenance of this plant essential to eliminate long hauls with street material. Available ground has been increased by filling out to the established bulkhead line. Most of the material required by the asphalt plant is delivered by water, and to continue this method it has been necessary to build a tunnel under the new drive to house a belt conveyor and pipelines for carrying material from a waterfront receiving hopper.

To reduce the length of haul necessary for garbage, a dumping board is also being constructed for the Department of Sanitation at this point. A building roughly 160x160 ft., roofed and sided with corrugated asbestos sheets, will house the wide dumping platform built over docks designed to accommodate two 150x

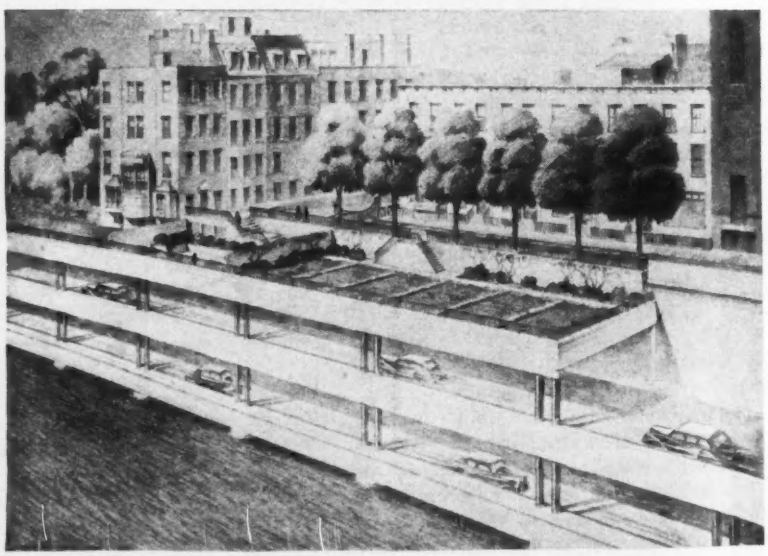


Fig. 4. Architectural rendering of the drive in the section where buildings and U. S. bulkhead lines force the structure into two levels. Top deck preserves the quiet and waterfront view of a high-type residential district.

MAJOR CONTRACTS ON THE EAST RIVER DRIVE

Description and Location	Section Engineer	Bid Amount	Contractor	Superintendent	Contractor's Engineer
Bulkhead, Sewer & Fill, 25th to 30th	J. T. Carroll	$783,585	A. M. Hazell, Inc	Henry Quist	Wm. Spelman
Paving & Landscaping, Montgomery to Grand	W. F. Morris	213,000	John Meehan & Son	Joe Concannon	
River Dredging, 34th to 54th	E. J. Smith, Jr	192,000	Great Lakes Dredge & Dock Co	L. Bouchard	C. E. Trout
River Dredging, 54th to 57th	E. J. Smith, Jr	310,800	The Arundel Corp	Wm. Mullin	S. Reich
Bulkhead, Sewer & Fill, 49th to 54th	Wm. Manning	698,980	Merritt-Chapman & Scott Corp	W. Hepworth	R. S. Harp
Bulkhead, Sewer & Fill, 59th to 64th	H. Wilson	808,900	Del Balso Construction Corp	J. Cichetti	J. Fitzgerald
Bulkhead, Sewer & Fill, 90th to 93rd	H. Sapiro	491,836	Allen N. Spooner & Son, Inc	M. Erickson	W. Cleverdon
Double-deck Road & Fndtn., 54th to 64th St	B. Schwerin	1,420,000	Poirier & McLane Corp	P. Jordan	R. M. Burkhatler
Double-deck Road & Fndtn., 79th to 90th	M. Kurcias	2,268,000	J. Rich, Steers, Inc	L. Van Houten	W. D. Malcolm
Sanitation Dept. Dumping Board, 91st St	H. Sapiro	557,830	P. T. Cox Construction Co., Inc.	J. Kinney	R. Tiernan
Underpass Conveyor to Asphalt Plant, 90th St	R. G. Biggerstaff	337,146	Anthony M. Meyerstein, Inc	G. Coxhill	A. Meyerstein
Paving & Landscaping, 81st to 90th	R. G. Biggerstaff	441,424	Madden & Lane, Inc	J. Brady	R. Johnsen
Paving & Landscaping, 49th to 56th	W. Manning	102,332	Joseph Leopold & Co., Inc	W. E. Carberry	J. Russell
Paving & Landscaping, 64th to 81st	H. Krumdieck	303,515	Frank Mascali & Sons, Inc	A. Grace	C. Walls
Paving Marginal Street, 60th to 63rd	J. Kiernan	127,929	Sicilian Asphalt Paving Co	Wm. McGarry	

36-ft. scows. A ramp over the drive will provide access to the building at dumping platform level. Modern ventilating and handling equipment will keep the dumping board sanitary and free from debris.

From 93rd St. to the semi-terminus of the drive at the Triboro Bridge entrance, the existing drive will be used, with pedestrian bridges added for access to the waterfront esplanade. It is hoped that sufficient funds can be obtained to open up some short service drives to accommodate local traffic so the present traffic lights can be eliminated and this section made into a non-stop roadway. Proposed development of a commercial area at 96th St. will shorten street hauls for coal and building material for use in this area and will make a valuable increase in water frontage, as there is no business section now between 63rd St. and 125th St. Ramp structures over the drive are planned for access to the commercial area, but construction is not yet under way.

Contractors on the work have used standard equipment and depended upon efficient use of usual methods for economic work. Bulkheads and the dumping board structure were generally handled by floating plant, though some of the concrete was delivered to the forms by concrete pump. Poirier & McLane (see table) was able to work along the narrow shore and take commercial transit mix deliveries direct to the work or chute it from the trucks on the high land along the river front. J. Rich Steers did most of its work from the water due to difficult accessibility from land and the fact that

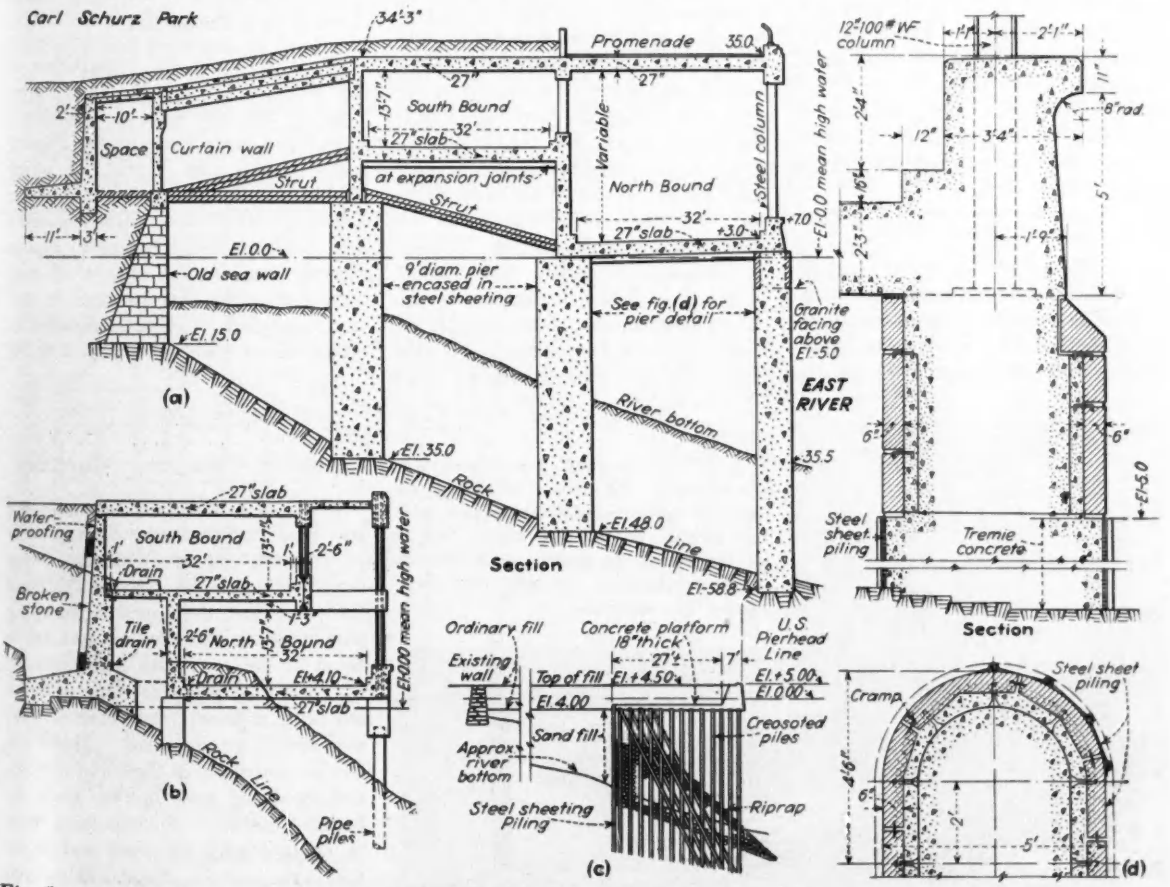


Fig. 5. (a) More than usually complicated section of the drive about 85th St. (b) Typical section about 57th St. Piling is 18-in.-diameter, ½-in. shell, closed-end; it is driven to rock. (c) Section where land is being added to Manhattan. Riprap is placed to stabilize the piles. (d) Outside pier and section through seawall and roadway.

adequate floating equipment was owned. Floating drivers placed the small sheetpile pier cells and derrick boats handled heavy equipment as required. A barge-mounted concrete plant, with the hoist tower supporting the discharge chute, mixed and placed the concrete.

Financing

Most of the drive is financed by assessment bonds. The full cost of the work in the larger parks is charged to the entire city. The lower end of the drive to 30th St. is assessed 80 per cent on the Borough of Manhattan and 20 per cent on the adjoining owners. The next section up to 49th, when constructed, will be paid for by the city as a whole, as dockwork usually is handled. For work above 49th St., PWA is furnishing 45 per cent of the $10,500,000. The city's 55 per cent is assessed half on the entire city and half on the Borough of Manhattan. The anticipated cost of completed and contemplated construction from Montgomery St. to 125th St., including all work from 30th to 49th St. is $32,000,000. This does not include land costs or damages but does account for money spent over the past several years for construction, particularly from 92nd St. to the Triboro Bridge at 125th St.

Contemplated work

The most essential work contemplated but not under way is the 30th to 49th St. section in midtown Manhattan described above. The connection from Montgomery St. to the Battery is of major importance. Present plans call for this to follow South St., now a congested waterfront access way. It is anticipated that traffic from the recently started Battery-Brooklyn Tunnel may eventually require uninterrupted flow up the East Side. Funds are being asked for the design of this section, probably as an elevated road similar to the West Side Highway, so that construction can be started when traffic trends indicate its necessity. Complete development of the East River facilities also requires construction of the waterfront Harlem River Drive from Triboro Bridge to the Old Speedway, and additional provision for crossing the Harlem River into the Bronx.

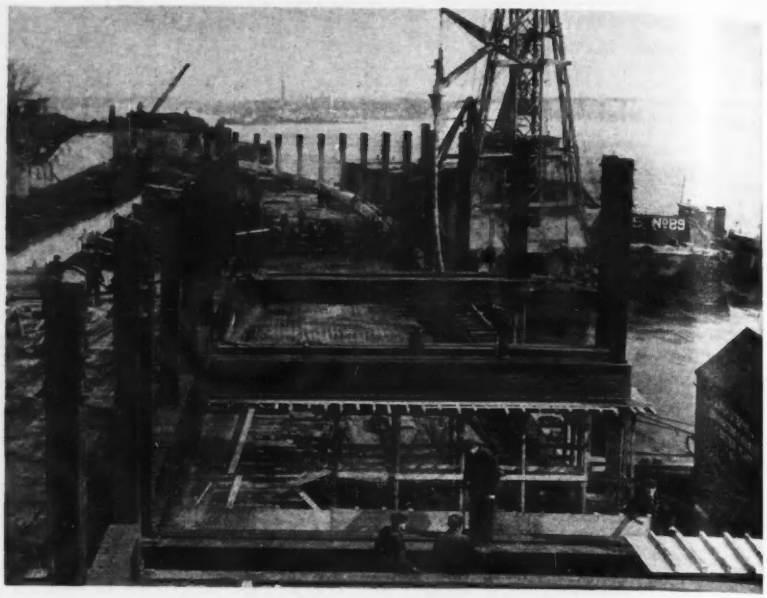


Fig. 7. Construction near 85th St. Floating mixer plant deposits concrete over a wide area of roadway which is spanned by finishing machine.

Personnel

Work is under the jurisdiction of the office of Stanley M. Isaacs, president of the Borough of Manhattan. It is being carried out by the Department of Borough Works, of which Walter D. Binger is commissioner; Lester C. Hammond, chief engineer; J. C. Collyer, design engineer; Pincus Rizack, engineer in charge of construction on the 49th to 92nd St. section; and J. E. L. Ryan, engineer in charge from Montgomery to 30th St.

Fig. 6. Piling cutoff just above low water ready for forms to carry reinforced concrete platform which will rest directly on the pile butts. This is an innovation in design as heretofore wood stringers on the pile caps have carried the concrete.

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Tunnel Cleaning Machine

For the removal of accumulated soot and dirt from the arched roofs of tunnels, the maintenance-of-way department of the French National Railways has developed a scraping and brushing machine. A box car is fitted at the rear with a fan-like arrangement of pipes or rods, each fitted with a short transverse scraper and brush on its head. There are two or more sets of these radial rods, staggered in position so that the brushes overlap. Springs hold them in contact with the roof and allow for variations in shape. When not in use, the pipe frames are lowered and rest horizontally over a gondola car which receives the dirt.

Hydraulic Model Studies Solve Backwater Gate Design

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Contents in Brief—Substantial economy in cost as well as an improvement in hydraulic characteristics resulted from a model study of a backwater gate structure built in Detroit. How the investigations were made and the manner in which the findings were used is described.

USE OF A MODEL for the development of a backwater structure required in the Detroit sewage disposal project resulted in an economic design both from the standpoint of actual cost and in the reduction of operating head, as compared to the structure first proposed. Subsequent verification of the laboratory results justified the confidence placed in the model work and indicates the desirability of wider use of models as a design procedure of real value.

In connection with Detroit's sewerage improvements, regulation chambers were required to intercept the dry weather sewage flow from the combined sewer system. One of the larger sewers intercepted drains 12,000 acres, and the stormwater and sewage from this area flows through Baby Creek to the Rouge River at which point the sewage flow is intercepted. The existing Baby Creek outlet, constructed in 1930, consists of a double box section, each box being 14.5 ft. wide by 17.5 ft. high, with a total capacity of 3,000 cfs.

The invert of the outlet at the Rouge River is at El. 77.3, while the water surface of the Rouge River varies between El. 90 and 96. Accordingly, backwater gates were required in order to intercept the sewage flow. To construct the new backwater structure, it was necessary to remove a portion of the existing double box outlet; and due to right-of-way requirements, the backwater structure was limited to a total length of 116 ft.

Hydraulic model tests

In order to arrive at the most suitable hydraulic design, scale models 1/24th of full size were constructed in the laboratory at Wayne University and tested in accordance with the Froude law of similitude. The original design submitted for test consisted of a structure having an overall width of 75 ft. and length of 116.5 ft. The flow was divided through six

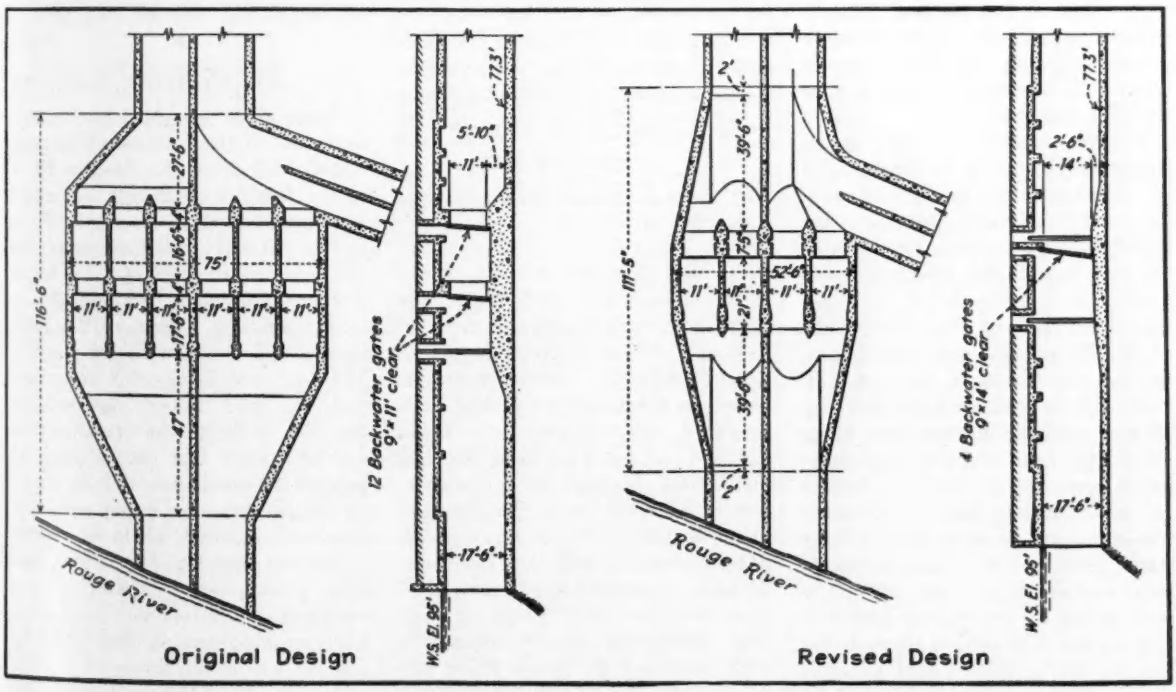

Fig. 1. **Model tests on the backwater structure with six channels (left) led to the revised design (right) which has only four flowing-through channels. The latter design provides smaller angular divergence, less turbulence, and more even distribution of flow.**

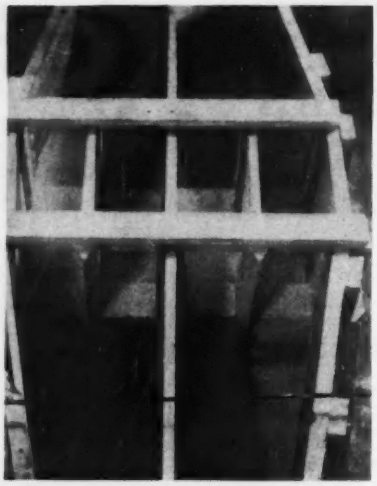

Fig. 2. Scale model on which tests were made of the revised design.

chambers in each of which a double set of gates was installed, each gate having a 9 x 11 ft. clear opening with sill 5 ft. 10 in. above the floor.

Due to length limitations, a rapid divergence was required to accommodate the six flowing-through chambers. At the design flow of 3,000 cfs and Rouge River elevation of 96, the velocity in the double box sewer is 6 fps, the corresponding velocity head being 0.56 ft. The theoretical velocity just ahead of the gates (assuming uniform distribution over the area) gives a flow of 2.48 fps with a corresponding velocity head of 0.09 ft. In passing through the six gates, the flow would again speed up to a velocity of 5.05 fps.

Thus this structure apparently introduced losses due to the slowing down and speeding up of the flow in its passage through the gates, the model tests indicating a total loss of 0.8 ft. through the structure when discharging 3,000 cfs at a Rouge River elevation of 96. Due to the rapid divergence, the distribution through the channels was not uniform, the outside channels carrying 20 per cent, the intermediate channels 35 per cent, and the inner channels 45 per cent of the flow. Numerous eddy currents were set up and it was apparent from a study of the model that hydraulic improvements could and should be made. Efforts to achieve this by introducing baffles to create even distribution through the six channels indicated that all such devices introduced in themselves an additional loss of head which more than compensated for any saving in head accomplished by the more uniform distribution to the channels.

It was apparent that a more suitable structure would be one having four flowing-through channels thus giving a smaller angular divergence and a consequent lesser amount of turbulence with a more even distribution through the channels. Also, it appeared preferable to maintain the velocity already existing in the sewer barrel and carry it through the structure as nearly as possible undiminished. In addition, since safety was not involved, it did not appear justifiable to install double backwater gates since one set of such gates would be adequate; and in the event of gate failure, no particular harm would be done.

With these thoughts in mind, the model was altered and a revised design developed.

Revisions in design

Accordingly, a structure having four backwater gates, each 9 ft. wide by 14 ft. high with sill height of 2.5 ft., was developed and modeled.

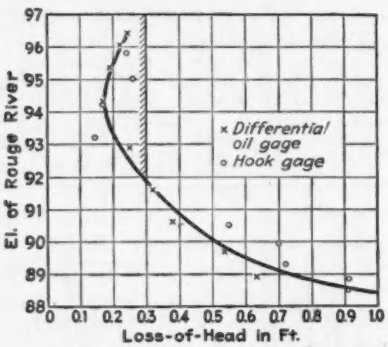

Fig. 3. Data obtained from model test with a flow of 3,000 cfs.

Since the total overall width of the structure was only 52.5 ft., it was possible to use a divergence angle of 1:5 and reduce the total length to 111.4 ft. After the contract drawings, based on the model study had been prepared, the structure was again modeled and tested for head loss. The model was operated at a prototype flow of 3,000 cfs, while the elevation of the Rouge River was varied. Loss-of-head was obtained both by means of hook gages and a differential oil gage. In the critical range of high river level, the model indicated a total loss from the Rouge River surface to a point at the head of the gates, of less than 0.3 ft. (Fig. 3). The flow was non-turbulent with uniform distributon to the gate chamber.

The structure was completed at a contract cost of $147,000 and placed in operation in January, 1939. On Feb. 19, 1939, it began to rain at 4:00 a.m., and by noon when the observations were made, a total of 1.23 in. had fallen in the 8-hr. period. The rain continued for a 24-hr. total of 2.41 in. The maximum observed flow, obtained by float and gradient measurements, was estimated at 1,600 cfs with a Rouge River elevation of 92.22. At this flow, the loss through the structure corresponding to the points of measurement used in the model, was 0.15 ft.

On July 3, 1939, another opportunity for testing occurred. It began to rain at 5:13 a.m. and in the next 30 min. one inch of rain had fallen. This storm was of unusual intensity, causing basement floodings in a portion of the drainage area. The maximum observed flow was estimated at 2,600 cfs based on observed gradients. The Rouge River elevation was 94.43; and with the above flow, the actual loss was 0.23 ft.

The model tests and the preparation of the revised design were carried out by the writer. Detailed designs for the structure and supervision of its construction were handled under the direction of George R. Thompson, city engineer of Detroit.

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The China-Burma Highway

Remarkable progress in the construction by the Chinese of the new motor road from the Yangtse River to the frontier of Burma was noted in a recent London lecture by F. B. Leach, formerly chief secretary for the Government of Burma. He stated that an automobile had been driven from Chunking, China, to Rangoon, Burma, approximately 2,000 miles, in 13 days, averaging 150 miles per day. The most difficult part was the last 350 miles to the frontier. "No one who knew that tangled mass of precipitous mountains, cleft by gigantic torrents and the upper waters of great rivers, could fail to be amazed at the engineering feat which had been accomplished, almost without mechanical appliances, by human labor working against time, when the country was in the throes of a disastrous war. It could have been accomplished only by the people who built the Great Wall of China."

Controlled-Stress Test of Plank

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A LOAD TEST which may be expected to detect weak planks, such as those of brashy material or those containing invisible compression failures, but which should not by any chance cause damage to a good plank is illustrated by the accompanying sketch.

Most scaffold planks are furnished in rather odd dimensions, 2 x 9 in. x 13 ft. long, and are made of eastern spruce which includes the species given in the accompanying table. For an example Picea Glauca, which is lower in all properties except the proportional limit under static load, is selected. It is assumed that under normal operating conditions the weight of only one man will be applied to the middle of a plank, but for test purposes, as required by some municipal and state regulations, a load three times the working load should be used in the test. Assuming the weight of a man to be about 160 lb., the test load will then be 480 lb. concentrated at the middle of the plank.

The actual size of a rough (unsurfaced) 2 x 9-in. plank is about $1\frac{3}{4}$ x $8\frac{3}{8}$ in., which gives a moment of inertia of 3.85 and a section modulus of 4.41. The 480-lb. load concentrated at the middle of the 12-ft. span (13-ft. plank) produces a bending moment of 17,300 in.-lb. The unit stress developed is about 3,920 lb. per sq. in., and the deflection about 5.8 in., or say $5\frac{3}{4}$ in. Now, if the deflection of the plank should be limited to $5\frac{3}{4}$ in. the stress developed would likewise be limited to 3,920 lb. per sq.in. Any static load in excess of 480 lb. will cause the middle of the plank directly under the load to touch and bear upon the floor, thereby relieving the plank of any further stress (except compression across the grain which is immaterial in this case). In other words, the plank cannot be stressed beyond 3,920 lb. per sq. in. when the deflection is thus limited to $5\frac{3}{4}$ in.

In the Picea Glauca plank, the ratio of the proportional limit under static load (6,500 lb. per sq. in.) to the maximum stress developed under the static test load (3,920 lb. per sq. in.) is 1.66:1. If the same plank is deflected the same amount ($5\frac{3}{4}$ in.) under an impact load the same stress is developed (3,920 lb. per sq. in.), but the proportional limit under an impact load is nearly twice as great (10,300 lb. per sq. in.), which gives a ratio of the proportional limit under impact to the maximum stress developed under the impact test load of 2.63:1. In other words, suddenly bending the plank $5\frac{3}{4}$ in. is much less likely to damage the plank than deflecting it the same amount under a static load.

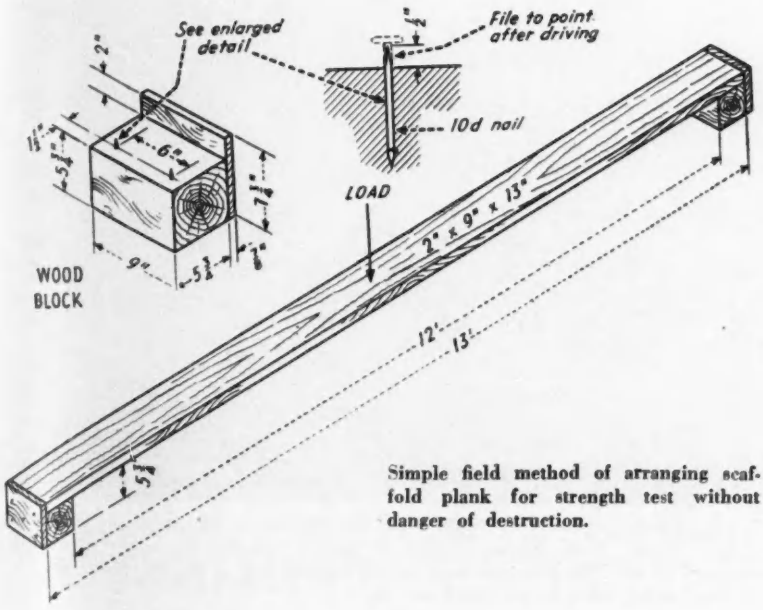
These figures are all based on a perfect plank. If a strength ratio (the ratio of the strength of a theoretically perfect plank to the strength of an actual plank with all its knots, checks, shakes and other defects), of 80 per cent is considered, then these ratios are reduced to 1.33 for a static load and 2.1 for the impact load. In either case, but particularly the latter, the stress produced is sufficiently below the danger point to insure against possible damage to a good plank.

Impact more desirable

It is therefore considered more desirable to apply an impact load to the plank. This should be accomplished by having two men stand near the middle of the plank and spring up and down until it touches or nearly touches the floor. If there is no cracking sound or other evidence of failure under the test, the plank should be inverted and the test repeated on the other face. Both faces must be tested to insure against the presence of compression failures.

There are certain peculiarities of wood which work out in favor of this method of testing. Brashy (brittle) wood and wood containing compression failures are much weaker under impact than is good wood, and these two defects are the most difficult to detect during the visual inspection of the plank. In other words, the impact test is more likely to cause failure of a defective plank and less likely to do damage to a good plank than is the static test for plank defects.

Strength characteristics of three species of spruces commonly used for scaffold plank are given in the following table:



Simple field method of arranging scaffold plank for strength test without danger of destruction.

Species	Modulus of Rupture lb. per sq.in.	Prop. Limit Static Load lb. per sq.in.	Prop. Limit Impact Load lb. per sq.in.	Modulus of Elasticity lb. per sq.in.
Picea Mariana	10,300	5,800	13,400	1,530,000
Picea Rubra	10,200	6,800	11,900	1,520,000
Picea Glauca	9,800	6,500	10,300	1,340,000

Wrecking a Chicago Landmark

Contents in Brief—Construction of the subway in the Chicago Loop district has created the problem of what to do with numerous old buildings along the route that rest on floating foundations. Rather than go to the expense of underpinning to rock, some owners are wrecking their old structures. Most famous of the latter case is the 14-story Great Northern Hotel, which is being demolished to make way for a lighter taxpayer. This job is a fine example of modern demolition procedure, comparable with best building erection practice in planning, coordination and safety of operation.

GHOSTS OF Chicago's Gay Nineties are being chased from the palatial old Great Northern Hotel as wreckers rip through the walls and floors of one of the earliest steel-frame skyscrapers. The famous old 14-story structure on Jackson, Dearborn and Quincy streets, completed in 1892 in time for the Worlds Columbian Exposition and known to thousands of travelers and early Chicago socialites, is being torn down because of floating foundations inadequate to withstand driving of the Dearborn St. subway tunnels. Marshall Field Estate, present owner, prefers to wreck the old building and replace it with a lighter taxpayer rather than to assume the expense of underpinning the floating foundation.

Analysis of the wrecking operations, being done by the Cleveland Wrecking Co. of Cincinnati, reveals a procedure as well planned, coordinated and carefully carried out as any building erection job. Instead of buying the various materials, transporting them to a congested site through busy streets, distributing and incorporating them into a structure in proper sequence, the wrecker's problem is one of stripping and tearing out of the materials in proper order, salvaging and selling what he can, keeping refuse and usable material separate in a congested ground floor space, and hauling everything away through busy Loop streets with a dispatch that keeps job operation moving swiftly and smoothly. Building construction hazards are intensified in wrecking, and demolition introduces some additional hazards, all of which demand a real safety program. The Cleveland Co. has developed a smooth-working demolition procedure that includes every possible safety feature. The schedule is fast, 90 calendar days from start to finish, which, with three weeks out for preparation, means two floors a week must be removed. To compensate for time lost due to bad weather, the wreckers work on a schedule of a floor every two days.

Early steel-frame structure

The Great Northern was one of the first all-steel frame high buildings erected in Chicago. Other structures of its time utilized wrought-iron columns and steel girders, but the frame of the Great Northern is steel throughout. The columns are built up of four Z-sections, riveted to a web plate. Main floor girders

Fig. 1. Ready for the scrap heap. Start of demolition operations on the Great Northern Hotel. Note the heavy sidewalk canopy and the two safety flares, one completed at the 13th floor, the other under construction at the 9th floor; the top flare was moved down to the 5th floor later.

are 20-in. I-beams, and floor beams are 6-in. I-beams. Some connections are riveted, but most of them are bolted. All of the steel is in excellent condition after being buried in the walls and floors for nearly half a century. The wreckers estimate there are 3,100 tons of steel in the structure; structural plans are not available.

Exterior walls are red face brick, trimmed with red sandstone, backed up with common brick. All interior walls and partitions are plastered hollow tile. Floors are hollow tile flat arches, covered with a thin layer of cement mortar and wood flooring, the only non-fireproof material in the whole building. Much of the interior trim, especially in the public halls, is marble, as are the lower stairways. The building is U-shaped, with a central court to the rear. The tips of the U's are party walls with two other buildings; as the hotel is wrecked these party walls must be restored to a safe condition to withstand exposure.

Preparation

Getting ready for the actual wrecking operations required nearly three weeks of preliminary work. First, three driveways were provided into the building from the Dearborn St. side, the center one leading to the rear court, from which all steel and heavy equipment is loaded; the two side driveways extend into the building just far enough to spot a truck under future rubbish chutes. The driveways consist of timber and planking carried on the first floor steel, adequately supported by adjustable shores resting on the basement floor. Another driveway was provided across the sidewalk at the Quincy St. side for loading out kindling wood and other bulky light material.

The next step was installation of a heavy steel sidewalk canopy, with a 6-in. timber roof, around the three exposed sides of the building. The canopy was kept away from the building, at the outer edge of the sidewalk, and was boarded up on the building side. For protection of truck drivers, the driveways were roofed over between the sidewalk canopy and the building.

As joint protection to both workmen and the public, the contractor installed a 10-ft. scaffold or flare, around the three exposed faces of the building at the 13th floor, and then another one at the 9th floor. As the building came down, the upper flare was moved to the fifth floor. The purpose of the flares is safety only, to catch men or material that might fall from above; they are not used as working platforms, but are designed for a loading of 200 lb. per sq. ft. The flares consist of 3 x 12-in. outriggers, 20 ft. long, set on edge, extending from the floor inside the building out over the window sills. The inside end is held down by a timber wale cabled to the floorbeams. They are fitted with a heavy timber deck and an outside timber wall about 4 ft. high. While single flares are common on high wrecking jobs, the Cleveland Co. insists on two of them, so one is always in place while the other is being moved.

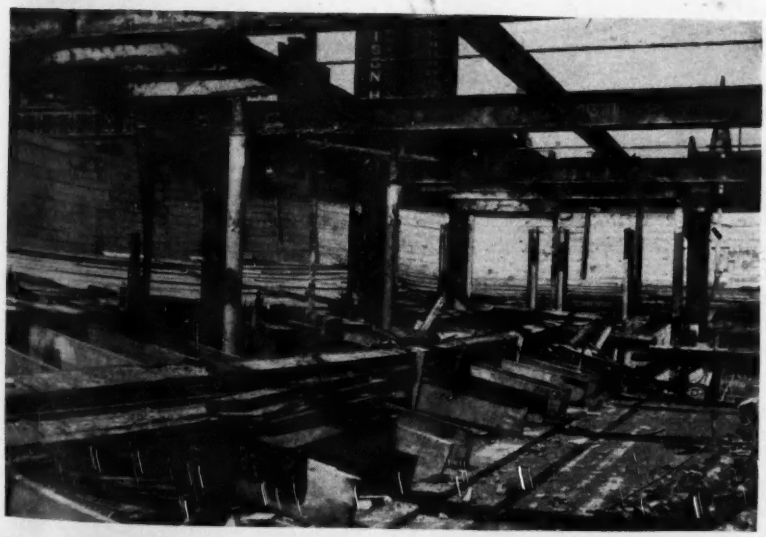


Fig. 2. The flares consist of outriggers tied down to the steelwork inside the building and extending 10 ft. beyond the outside wall. They are for safety only, are not used as working platforms.

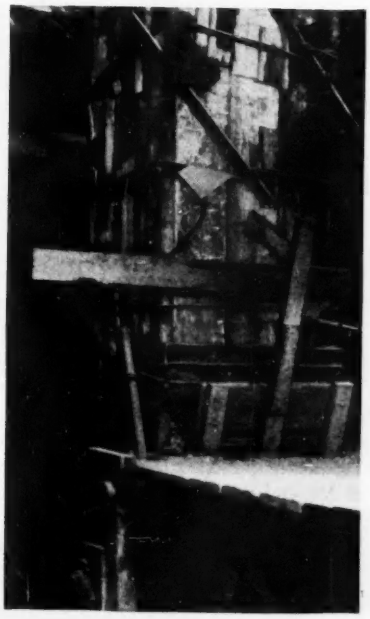


Fig. 3. Bottom of one the two debris box chutes, ending at the 2nd floor. The hand gate controls the flow of material into waiting trucks below. Because of the weight of a chute when full of debris, it is trussed up to the columns at 3rd floor level to relieve the 2nd floor steel.

Two vertical box refuse chutes were installed from the top to the second floor. These are 3 x 4 ft. in cross-section, built up of heavy planks set vertically, bound by cable bands at every floor. When full to their maximum height each chute holds about 60 cu. yd. of refuse. To take this load off the second floor steel, the chutes were trussed up by cables to the columns at third floor level. At one side near the bottom of each is a hand-operated slide gate which permits dumping through an incline chute directly into trucks below.

A third chute, of the inclined open trough type, was installed from the roof to the 8th floor; and from the 8th to the 2nd floor, terminating at the Quincy St. side. This is for kindling wood, and all such material has to be rehandled at the 8th floor and again at the 2nd floor for loading into trucks below.

Steel and other heavy items are

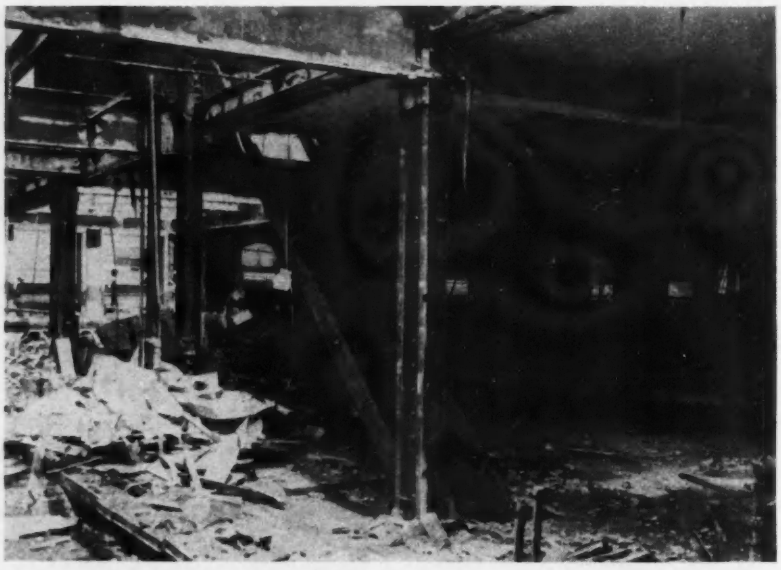


Fig. 4. An inclined trough chute was built from top to the 8th floor, then double back to the 2nd floor. It is used for wood debris only, material that would clog the box chutes. Note how part of the floor above has been stripped ready for removal of steel.

gang. Rubbish from the partitions is dumped down the vertical chutes through doors installed at every floor.

In operations on the typical floors, two stories are worked together. For example, by the time the structure above the 14th floor was cleaned off to floor level, the 14th floor arches, fireproofing on the columns in the 13th story and the 13th story exterior walls in the north part of the structure were knocked down onto the 13th floor, loaded in wheelbarrows and dumped down the refuse chutes. When the masonry crews moved to the south part of the 14th floor and 13th story columns, the steel gang worked on the exposed framework above the 13th floor on the north side.

Steel salvage

The steel frame members and heavy piping are cut loose with acetylene torches. Each beam, girder and column is snubbed with ropes as it is cut loose, then lowered to floor level

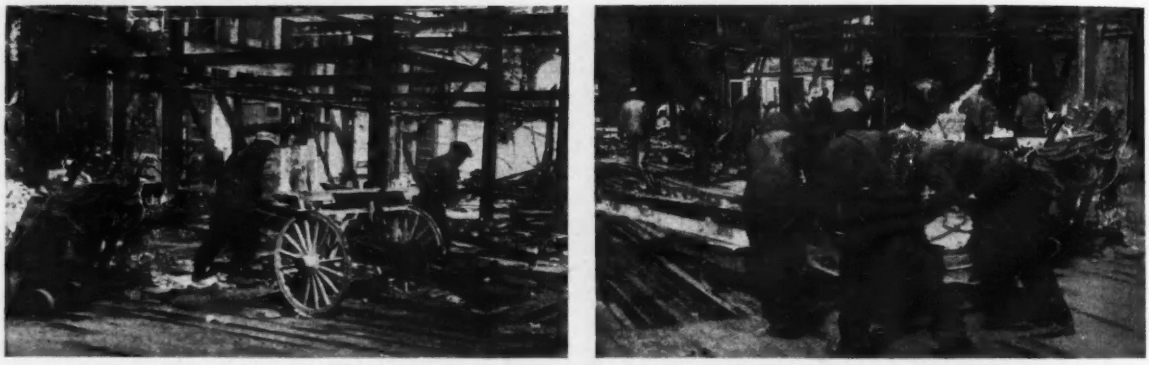


Fig. 5. Steel sections, after being cut loose and lowered to the floor, are moved to within reach of the derrick by a chain cart (left) or, if light enough to be lifted by hand, by a dolly.

lowered into the back court by a 10-ton derrick consisting of a mast, boom and one stiffleg. The mast is placed outside of the rear wall, the stiffleg extends back into the building. It was first set up on the 12th floor, and is jumped down two floors at a time. A gas two-drum hoist set on the ground operates the boom and hoist lines; the swing is by tag lines.

As the chutes, canopies, flares and derrick were being installed, other crews went through the building stripping all salvageable material such as floor coverings, windows, doors, light and plumbing fixtures, and marble. The elevators were kept in service all through the preliminary operations, and were utilized for removal of this material.

Real demolition of the building started at the roof, and because of penthouses, elevator equipment, stacks, water tanks and ventilating equipment, the top job was equivalent to three stories of regular operation. It was a messy job to clean off the roof, and routine operations didn't get under way until the 14th floor level was reached in demolition operations.

Partition removal

Meantime, the interior gang was busy stripping out the partitions, starting at the top. Partitions are kept stripped from five to seven floors below top operations, which keeps the inside gang clear of all heavy wrecking operations and leaves only the main structure for the top cleanup without dropping. Every effort is made to cut the steel into salvageable lengths, but the fast schedule interferes with the best results. The lighter steel sections are loaded onto a small dolly and wheeled to within reach of the derrick; heavier sections are picked up and moved with a two-wheeled chain cart. Because the derrick step is cantilevered a short distance out from the building, the boom tip can be swung around over the top floor far enough to pick up a load of material.

All pipe, steel and miscellaneous metal go down the back court by derrick, as it is all sold to one dealer. Small stuff and scrap is loaded into skips consisting of half boiler shells salvaged from the basement. The gas and oxygen tanks are also hauled

up and down in these boiler skips.

Brick and tile masonry are broken down with bars, picks and mauls. The workmen, all experienced union wreckers, have an uncanny knack of breaking up a solid brick wall under their feet with perfect control of the falling of the dislodged material. Seldom does a brick drop on the wrong side of the wall. The masonry refuse is loaded into wheelbarrows and dumped down the box chutes.

Considerable planning is necessary to keep the various operations coordinated, to keep the job clean, and to distribute the men so they do not work under each other. The full structural strength of the floors and frame must not be impaired as long as they are utilized for the wrecking work. Because of the lowering and loading out of steel in the court, which requires men working unprotected on the ground floor in the court area, demolition of the walls facing the court is done by a special gang working during the noon hour and after regular hours.

Safety measures

Every attention is paid to safety. Telephone communication is maintained through a switchboard in the field office between the job office, timekeeper's office and top floor of operations. A new 3-in. water line was installed from basement to the top, with taps and hose lines at every floor for fire protection. The water line is hooked up to a centrifugal pump that maintains 160-lb. pressure on the riser. After the windows were removed the openings were boarded up with partition doors to protect workmen stripping the interior from cold winds, and also to prevent any materials falling or being thrown from the windows. Hoist signals are by bell cord, and hoist operations which require presence of men in the court area are discontinued when work is under way on the walls facing the court. Workmen whose duties place them in exposed locations wear hardboiled hats.

Fig. 7. Telephone communication is maintained at the top floor with the offices on the ground. Superintendent John Powell is checking up on truck movements without having to climb down and up 14 stories.

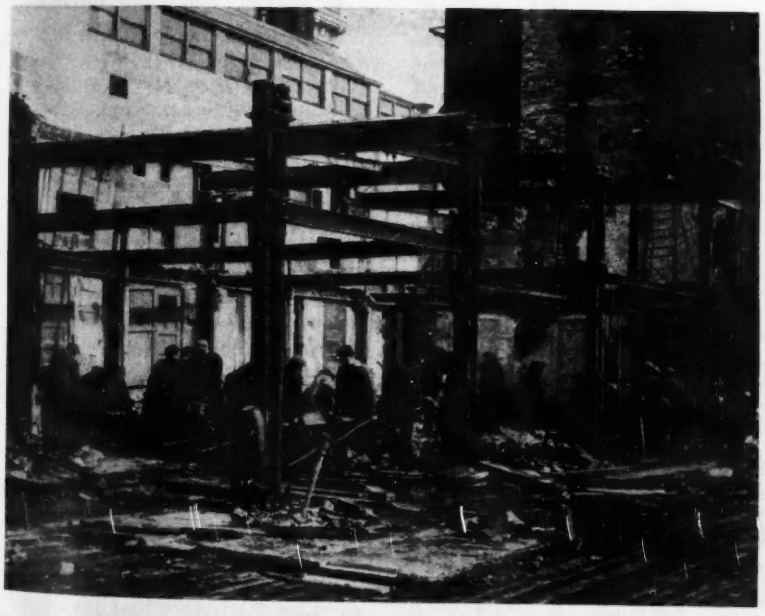


Fig. 6. Wheelbarrow gang cleaning up masonry debris while the steel crew (far right) starts cutting down another bay.

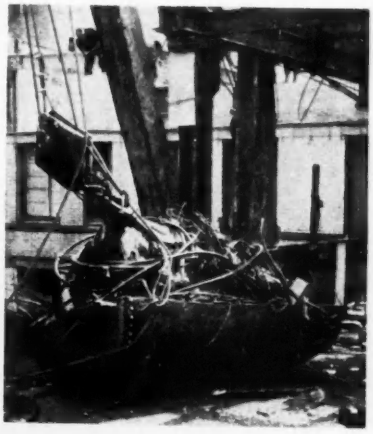


Fig. 8. Half a salvaged boiler shell makes an ideal skip for lowering a mess of old pipe and cables by derrick.

When the 3rd floor is reached the use of chutes and the derrick will be discontinued and the remaining materials will be dropped into the basement. Cranes working from street level will then clean up with clamshell buckets.

Because of the fast schedule on this job not as much material is being salvaged as is customary. No attempt is made to save the brick or stone, and the steel has been sold for scrap along with piping and other metal. Anything of value not sold at once is shipped to one of the wrecking company's 21 warehouses located throughout the country. From thirty years of experience in building demolition the contractor knows just what materials will move in different localities.

Direction

Shaw, Naess and Murphy, architects, Chicago, represent the Marshall Field Estate on the project; Henry H. Bushee is the resident engineer. The wrecking contract is held by the Cleveland Wrecking Co., Cincinnati, Ohio. S. G. Rose, vice-president and general manager, and C. H. Rose, Western vice-president, are directing the operations here, carried out by 200 workmen, and other projects involving 2,000 workmen from coast to coast. John Powell is superintendent of the Great Northern job.

Detecting Unsound Chert in Aggregates

CHARLES E. WUERPEL

Engineer in charge of Central Concrete Laboratory
North Atlantic Division, U. S. Engineer Department, West Point, N. Y.

Contents in Brief—Study of unsound concrete aggregates containing chert showed that pebbles of low specific gravity are the source of trouble. They can be separated by flotation in a heavy liquid. Apparatus for carrying out the separation is described.

DISFIGURATION and disintegration of concrete structures made with coarse aggregate containing unsound chert pebbles has given much concern. Chert or flint pebbles are present in most sedimentary gravels, in a range of colors from dull white to gray, brown and black, and with varying degrees of hardness and physical appearance. Some of them are a mass of replaced fossils or oolites, some contain appreciable amounts of calcium carbonate or iron oxide, and some are uniformly dense cryptocrystalline silica. The resistance of this variable material to frost action varies from very high to very low.

Practical methods of differentiating between durable and non-durable chert have not been available, and in consequence all varieties of this material are viewed with suspicion. Some gravel aggregates have been rejected because of stringent limitations on the mineral without real knowledge of its structural soundness. In other cases the inability to differentiate between unsound chert and other waterworn iron-bearing pebbles has resulted in the use of gravel which contained a dangerous quantity of this undesirable material.

There have been cases where a local aggregate has been rejected because of its chert content and distant aggregate has been imported at considerable cost, when the massiveness of the structure would have been a protection against deterioration due to mild frost exposure. In the southeast many concrete highway bridges containing such aggregate throughout show numerous pop-outs in the handrails, fewer in the curbs and slabs, and none in the more massive abutments. This conditions is caused by the sun's heat stored up in the more massive sections serving as protection against brief decline of the air temperature below freezing.

The seriousness of the chert problem can be greatly lessened by practical means for quantitative estimation of unsound chert. By use of such means, also, more intelligent specification limits can be placed on chert.

Gravity separation

When the relative quality (with reference to chert) of two major gravel deposits was to be determined, the methods suggested in the available literature were found to be faulty and uncertain. Published data on chert indicated that practically the sole thread of accord was a general relation between apparent specific gravity, absorption and durability. This accord was of little real value, however, because of the practical impossibility of determining the absorption or apparent specific gravity of chert particles in representative samples of gravel in sufficient number for acceptance or rejection. Application of the test of high absorption-low durability, or else low apparent specific gravity-low durability, to an entire gravel sample was considered inadequate, because it would be possible for a small but dangerous percentage of chert to be undetectable in a gravel sample of generally low absorption or high gravity.

Table I — RELATIONSHIP BETWEEN APPARENT SPECIFIC GRAVITY, ABSORPTION AND SOUNDNESS OF CHERT GRAVELS

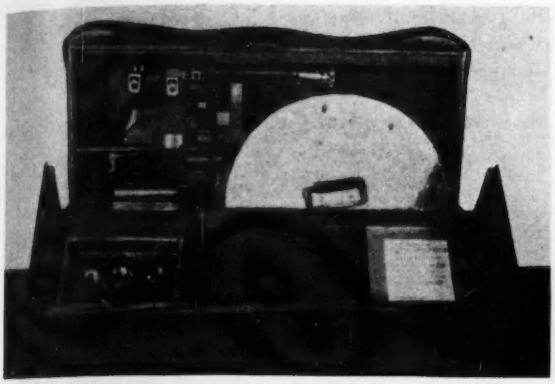
Sample	Apparent Specific Gravity	Distribution in per cent	Absorption	Loss in weight 10 cycles $MgSO_4$
S-1	+2.50	36	1.5	2.1
	2.40 to 2.50	19	2.6	5.4
	2.30 to 2.40	16	6.1	11.4
	−2.30	29	3.9	36.0
S-2	+2.50	51	1.0	1.9
	2.40 to 2.50	32	2.2	3.5
	2.30 to 2.40	10	4.2	6.7
	−2.30	7	8.0	22.4
S-3	+2.50	55	1.0	1.7
	2.40 to 2.50	29	2.4	4.3
	2.30 to 2.40	12	4.4	9.3
	−2.30	4	7.2	17.3
S-4	+2.50	54	1.0	1.8
	2.40 to 2.50	27	2.5	3.1
	2.30 to 2.40	13	4.3	6.2
	−2.30	6	7.6	13.4
T-1	+2.50	14	2.1	7.3
	2.40 to 2.50	37	3.3	4.5
	2.30 to 2.40	30	5.6	11.1
	−2.30	19	7.3	14.2
O-1	+2.50	79	0.4	2.6
	2.40 to 2.50	12	2.7	6.0
	2.30 to 2.40	6	4.7	9.0
	−2.30	3	9.1	20.4
W-1	+2.50	86	1.3	2.6
	2.40 to 2.50	8	3.7	5.8
	2.30 to 2.40	4	5.8	13.1
	−2.30	2	9.4	45.7
NOA	+2.50	81	0.3	2.5
	2.40 to 2.50	12	2.3	4.0
	2.30 to 2.40	6	4.5	11.0
	−2.30	1	9.1	18.0
BC	+2.50	91	0.1	10.2
	2.40 to 2.50	7	1.9	2.0
	2.30 to 2.40	2	5.6	5.0
	−2.30	0	.....	.....

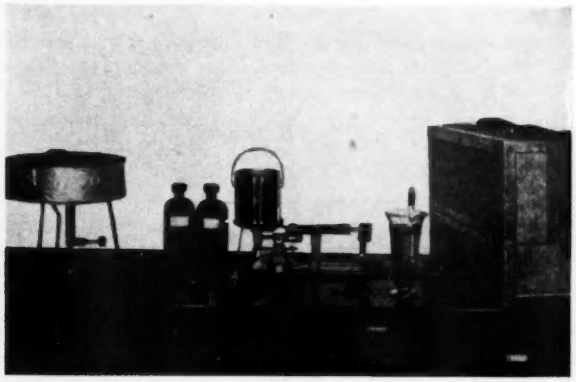
[1] Unsoundness due to presence of non-durable sandstone.

It was obvious that some means of separating the low-gravity cherts from the remainder of the gravel must be perfected before tests could be made to determine the gravity-durability relationship. After trying various combinations, monobromobenzene (specific gravity 1.46) and bromoform (specific gravity 2.86) were adopted as components of a flotation solution to be used for separating the particles. Solutions having specific gravities of 2.30, 2.40 and 2.50 were prepared and representative samples of the cherty gravels were separated by use of these solutions into four groups: −2.30; 2.30–2.40; 2.40–2.50; and +2.50.

Initially, the separation was conducted on four samples of gravel having very high chert content. The separate gravity groups of each of these gravels were examined with a petrographic microscope and tests were made for absorption, true specific gravity, resistance to the magnesium sulphate accelerated soundness test, and resistance to frost action when confined in concrete.

Microscopic analysis indicated that all of the cherts were basically cryptocrystalline silica contaminated in varying degrees by other minerals.





Chert flotation equipment packed for transportation, and as set up for gravity separation.

Carrying case:
Oak plywood with copper strip along corners and edges; lock and leather carrying handle. Shelves, inserts and containers for holding parts during transportation. Weight, 31 lb.

Flotation solution:
500 c. c. of bromoform—monobromobenzene with specific gravity desired (usually 2.40) in glass corked bottle. Weight full, 5.3 lb.

Dilutant:
500 c. c. of monobromobenzene in glass corked bottle. Weight full, 4.2 lb.

Hydrometer:
In carton. Range 2.00–3.00, calibrated in increments of 0.01 and accurate to 0.02 specific gravity. Weight, 0.4 lb.

Dipping spoon:
Wire mesh spatulate and on brass rod 8 in. long. Weight, 0.1 lb.

Flotation container:
500 c. c. conical glass graduate. Weight, 1.5 lb.

Boiler:
Circular metal pan with cover of sufficient capacity to contain 20 lb. of pebbles plus sufficient water to cover. Weight, 1.8 lb.

Tripod:
Circular metal tripod to support boiler over burner. Weight, 2.2 lb.

Burner:
Gasoline, Barthol type. Weight, 1.5 lb. A substitute may be used, but the small size, efficiency and light weight of this burner are advantageous.

Fuel can:
1-gal. tin can for gasoline. Weight, 0.3 lb.

Scale:
Eimer & Amend No. 17026 Solution Scale Triple Beam balance (Chaus) or equivalent with two 1000-g. and one 500-g. extra weights.

Cans:
2 ½-gal. paint cans for separated samples after flotation. Weight, 1.2 lb.

Rags:
Rags or towels for hand drying boiled samples and for packing around equipment to eliminate chances of breakage in kit during transportation.

principally iron oxide, clay and calcium carbonate. Very little chalcedony and practically no amorphous (opaline) silica was detected in any of the samples. The cherts varied from a highly fossiliferous or an oolitic structure to a uniform, dense non-fossiliferous texture. However, irrespective of adulteration by other minerals or type of structure it was found that the light particles (below 2.40) were extremely porous, many of the pores being of the sealed or semi-sealed type. As the apparent specific gravity increased the pores decreased in number and generally in size. Boiling in Canada balsam indicated that many of the high-gravity cherts contained pores of sub-microscopic size.

Absorption tests checked the apparent specific gravities. Absorption decreased markedly as gravity increased. The true specific gravities, determined from finely pulverized samples, were found to be practically identical ($2.65 \pm .02$) showing that the difference in apparent specific gravity was due to pores. Resistance to the sulphate test diminished as the apparent specific gravity diminished. Resistance to freezing and thawing also decreased. This test was conducted by freezing and thawing concrete disks containing pebbles of individual gravity groups; the results were of the order mentioned, but they were not in such form as to give figures for tabulation. The adjoining table gives the data for the four chert samples investigated, (S-1, S-2, S-3 and S-4).

Gravels from other geographical areas were studied. The results (T1, O1, W1, NOA, BC in table) were generally similar. It was found, however, that other materials than chert would float in the lighter solutions. Lignite, wood, coal and highly absorptive shale were easily detectable, but some highly porous sandstones were difficult to distinguish from chert. The shales and sandstones had absorptions in excess of 10 per cent by weight and it was the buoyant effect of the water in their voids which influenced their apparent gravity. All of the non-cherts which floated in the 2.30 and 2.40 solutions were definitely unsound and undesirable for use in concrete.

A more serious condition, which reflects upon the complete reliability of the flotation procedure as a criterion for unsound chert determination, was the detection of some unsound chert particles in the higher gravity groups. Microscopic and chemical examination established that their unsoundness was due to a relatively large iron oxide content, the high gravity of the iron offsetting the buoyant effect of the pores. In a few cases the quartz that sealed fractures in the chert particles had been completely or partially replaced by iron oxide, and failure by splitting resulted.

Except for the limitation noted, which prevent the method from being an absolute test, flotation provides a simple mechanical procedure for the field man who has to select and approve aggregate deposits and routine shipments. It offers a valuable tool to the research engineer. The procedure is as follows:

Apparent Specific Gravity—The apparent specific gravity referred to herein is that obtained by the formula $\frac{B}{B-C}$ in which B is the saturated surface-dry weight and C is the saturated weight in water. The saturation used is based on 5 hr. boiling in water.

Sample—The sample should be representative and, after careful quartering, should contain approximately 10 lb. of material coarser than the 3.8-in. sieve and finer than the 1-in. sieve. (If the coarse aggregate has a maximum size of 2 in. or more, a second sample weighing approximately 20 lb. should be selected which passes the 2-in. sieve and is retained

on the 1-in. sieve). The sample, or samples, should be boiled in water for 5 hr., cooled to air temperature, hand dried to a saturated surface-dry condition and weighed.

Flotation—The weighed sample should be introduced, in successive small portions, into a 500-c.c. conical glass graduate (or 500-c.c. separatory funnel) containing not less than 400 c.c. of a solution of bromoform (specific gravity 2.86) and monobromobenzene (specific gravity 1.46) having a specific gravity of exactly 2.40 (or other desired gravity). The pebbles which float in the solution should be removed by a dipping spoon, hand dried and weighed to determine the percentage of the total sample lighter than the specific gravity of the solution. The solution is slightly volatile and must be maintained at the specific gravity desired by the addition of monobromobenzene when needed. The specific gravity of the solution must be checked frequently.

Equipment—The equipment used in the investigation is shown on p. 81, both packed in a portable kit for field use and assembled for use. The kit was made by the Bowen Co., Bethesda, Md.

Separation of samples, including preparation, boiling and flotation, may be accomplished in about 8 hr.

The writer is indebted to E. P. Rexford, associate petrographic microscopist, for the microscopic analyses, and to M. R. Smith, Sam Goldman and Joseph Bayer for assistance in the physical tests. Acknowledgment is made also to the U. S. Engineer offices at Vicksburg and Louisville for some of the samples used, and to Stanton Walker, director of research of the National Sand & Gravel Association, for helpful suggestions on the flotation procedure.

Holes Pre-Bored for Underpass Falsework

Contents in Brief—In constructing a four-lane underpass under three busy tracks of the B. & O. C. T. Ry. in Chicago, the railroad was unable to drive the falsework piling through a hard clay and shale formation, so used an earth drill to pre-bore holes for the piles. The operation proved fast, economical and satisfactory, resulting in perfectly aligned falsework carried below footing level.

IMPROVEMENT of Archer Ave. as a four-lane route by the Illinois Highway Department required an underpass under three tracks of the Baltimore and Ohio Chicago Terminal Ry. in Argo, just west of the Chicago city limits. Under an agreement with the state the railroad was to design and build the falsework structure necessary to carry the tracks during the construction of the underpass bridge. Examination of underground conditions encountered while digging for a deep sewer that will drain the underpass and an unsuccessful attempt to drive a test pile convinced the railroad engineers that customary driving of piles for the falsework through a hard clay and shale formation from 8 to 20 ft. thick would be impossible. The difficulty of getting the piles through the hard ground was met by pre-boring holes with an earth drill through this material, setting up the piles and driving them to below footing level a few feet through similar formation and sand.

Plans called for raising the tracks 2 ft. at the crossing, the maximum possible because of nearby industrial connections. The railroad built the falsework to the new grade and was therefore able to install the stringers and caps with little excavation. The highway was closed for the entire construction period.

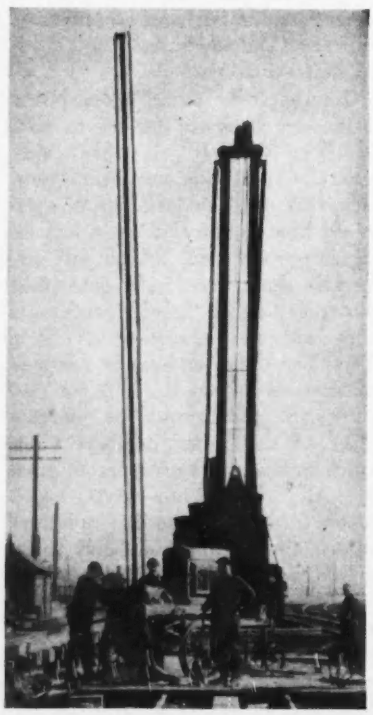


Fig. 1. Earth drill pre-bores holes for falsework piling. Piledriver then sets piles and drives them 3 or 4 ft. for a toehold.

The underpass bridge will consist of a cantilever abutment and a row of columns along the curb, on common footings, on each side of the roadway. The deck will be three spans of I-beams carrying concrete deck slabs, with a clear roadway span of 49 ft. 8 in.; the deck will be built alongside and rolled into place. Falsework to carry each of the three tracks during construction of the permanent structure included three single four-pile bents and four double four-pile bents, 44 piles per track. One track required an extra bent, bringing the total number of piles up to 136. The temporary bridge for each track consisted of two 24-ft. spans of 27-in. w.f. steel beams and six spans from 11½ ft. to 11 ft. 10 in. of 8x16-in. timber stringers, all resting on 12x12-in. timber grillage on top of the pile caps.

Examination of the ground at the site revealed a formation of clay and shale increasing in hardness with the depth, extending from the surface to about 20 ft. below. Underlying this formation is a layer of clay and small boulders and a few sand pockets, then more hard clay. Footings for the permanent bridge lie in the bottom clay about 24 ft. below the

Fig. 2. Underpass falsework for which pile holes were prebored by an earth drill. Note excellent alignment of the piles.

surface, though the subgrade to the roadway is much higher. The railroad desired to get the piles for the falsework alongside the footing below bottom of the foundation, and those at the center roadway to below the subgrade.

Pre-bored pile holes

After determining that the falsework piles could not be driven the railroad rented a Buda-Hubron earth drill, trailer model, connected to a 40-hp gas engine. At first a 16-in. auger was used, but because it was impossible to brace the falsework until the general excavation had uncovered the piles, a 12-in. auger was substituted to give the piles a tight fit in the holes and thus provide some lateral stability in the early stages of the excavation.

Speed in building the falsework was essential because of approaching winter, then, too, there were more than 100 freight trains over the tracks daily and only one track could be out of service at a time. The holes were bored from original track level; the drill rig worked from a timber platform on the rails. Ties were pushed aside to allow the drill to bore the holes between the rails.

Three men were on the drill, one as operator and two cleaning away the spoil as it was dumped from the auger. The auger consisted of a helical plate, driven by a splined vertical shaft, and was equipped with a flap that prevented the material from falling back into the hole as the auger was lifted out. In this particular material, when the auger had penetrated about 18 in. it was raised to the surface and the rotation speeded up to throw the spoil from the plate. A wood collar at the mouth of the hole kept the earth from spilling into the bore.

For all piles going to below footing level an attempt was made to drill the holes to a depth just above the projected bottom of pile, or about 24 ft. deep. In most cases this was possible, but in a few instances the auger struck boulders too large to dislodge, and the drilling stopped short of the desired depth. Where it was impossible to drive the piles as deep as desired they were tied with additional bracing as excavation progressed.

Drilling was intermittent, as it was tied in with the piledriving, which followed about two bents behind. The drill was in use seven days for the first track, five days for the second, and four days for the third, showing how the operation became increasingly efficient. The entire falsework was built in one month. The average time to drill a hole was 1 hr.; the entire cost for drill rent, fuel, service and parts, excluding labor, was $510. As a total of 2,264 ft. of hole was drilled, the cost per ft. was about 22½c.

Steel points satisfactory

Steel points were used on all piles in the double bents, which went below footing level. A few of the points have been exposed by subsequent excavation, and there is no indication of brooming or cracking, though some of the piles were hammered with a 3,500-lb. hammer for an hour to get the last foot of penetration. The bents were braced as general excavation progressed. In all cases the piles were found to be in perfect alignment and clear of all footings of the structure.

Usually, considerable maintenance is required on falsework structures of this type, but the railroad has not found it necessary to replace any of the piles with timber supports to date. This has saved, according to the engineers, a considerable amount of money which would probably have been spent for maintenance had the piles been driven without pre-boring. Their experience on other similar jobs bears out these contentions.

Direction

The falsework was built by railroad forces under the direction of G. P. Palmer, engineer of maintenance and construction, B. & O. C. T. Ry., Chicago. The Leininger Const. Co., Chicago, has the general contract for the underpass.

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Improvement Works At East St. Louis, Ill.

A considerable amount of track relocation and grade separation remains to be done at East St. Louis, Ill., to complete the extensive revision of the network of railway lines in the city. Grade separation at Broadway has been completed, but no definite plans have been made for further work in 1940, and no date has been set for the construction of the new union station which is to form a part of the improvements. Meanwhile, all the East Side railway approaches to the Municipal Bridge over the Mississippi River have been completed and put in service for entrance to St. Louis, Mo., by this new route.

Delaware Aqueduct—III

Designing the Aqueduct

Contents in Brief—This third article of a series on the Delaware water supply project deals with design considerations affecting aqueduct construction. Shaft and tunnel lining determinations, methods of roof support, grouting procedures, and the installation of underground powder magazines are described. Other articles appeared in the issues of Apr. 11, p. 513, and Apr. 25, p. 584.

THE DELAWARE AQUEDUCT, like the previously built Catskill Aqueduct is designed throughout for a capacity in excess of the estimated safe yield. The reasons for this are threefold:

(1) to accommodate seasonal variations in demand;

(2) to replenish Kensico reservoir when it shall have been drawn down because of a shutdown of either of the aqueducts, Catskill or Delaware, from the north; and

(3) in seasons of abundant runoff, to permit the use of gravity water which would otherwise waste from Rondout reservoir and from the higher Croton reservoirs, thereby both reducing the cost of pumping the low-level supplies and conserving the Long Island groundwaters for use in dry seasons.

The Delaware Aqueduct tunnel will be circular and concrete-lined throughout, the concrete lining having an average thickness to the rock breakage line of about 2 ft. The Rondout-West Branch tunnel will have a finished diameter of 13½ ft., the West Branch bypass, the West Branch-Kensico tunnel, and the Kensico bypass of 15 ft., and the Kensico-Hill View tunnel of 19½ ft.

The increasing diameter of the successive portions downstream is due to progressively flatter gradients, to the increase in capacity necessary to accommodate the water to be taken in from the higher Croton reservoirs and, in the case of the Kensico-Hill View tunnel, to the necessity of providing sufficient capacity to handle not only the average but the peak rates of demand so as to utilize Kensico reservoir as an equalizing or distributing reservoir. (For plan and profile see *ENR*, Apr. 25, 1940, p. 587.)

Of the 31 shafts of the Delaware Aqueduct, 12 are waterway shafts conducting the entire flow of the Aqueduct into or out of the tunnel, from or to the terminal and intermediate reservoirs, or into and out of the bypass tunnels, or to and from the Eastview filter site. (Terminal shafts 1 and 1A-North and double shafts 9, 10, 17, 18 and 19). These shafts have the same finished diameter as the tunnels to which they connect, except that none is smaller than 14 ft. and that the shafts at the ends of the 15-ft. Kensico bypass and the

Fig. 1. Steel roof supports of many types are in use. This is the Gothic rib type with battered legs in a 15-ft.-diameter section.

Fig. 2. Segmental rib type of steel roof support. Note the H-beam wall plate and skeleton logging in place on the top flange.

uptake shaft to Hill View reservoir are 18 ft. in diameter.

Three shafts, Nos. 6, 13 and 23, called drainage shafts, will be equipped with pumps, elevators, etc., for the convenient unwatering of, and access to the Rondout-West Branch, West Branch-Kensico, and Kensico-Hill View tunnels respectively. The West Branch bypass and the part of the Kensico-Hill View tunnel between Shafts 18 and 19 will be equipped with valves whereby they can be drained into one of the adjacent tunnels when the latter is unwatered. At Shaft 18 Uptake, a permanent pump chamber and suction and discharge pipes built into the shaft lining will be provided for the installation of station pumps to unwater Kensico bypass, which is deeper than the adjacent tunnels, after the water in the shafts has been lowered with sinking pumps.

Nine shafts including the three drainage shafts will be equipped with concrete-lined steel riser pipes of 4 or 6-ft. diameter, terminating at the shaft head in underground valve chambers. Through one of these (Shaft 4) water from the Delaware system can be fed into Catskill Aqueduct, which crosses the line of Delaware Aqueduct at this point. The other eight shafts (5A, 6, 11, 13, 20, 21, 22 and 23) will afford connections for the supply of neighboring communities outside of New York City if and when they elect to take water from this aqueduct. At two shafts (11 and 13) these risers can also be utilized to pump water into the aqueduct from the adjacent Croton Falls and Cross River reservoirs of the Croton system. Two of the shafts built primarily for construction purposes (2A and 8), will be left open to act as surge shafts and to afford additional means of access to the tunnel when unwatered. The remaining eight shafts (2, 3, 5, 7, 12, 14, 15 and 16), each 14 ft. diameter inside the concrete lining, are for construction only and will be sealed at top and bottom on the completion of the tunnel.

Shaft and tunnel linings

All construction and waterway shafts as well as the tunnels are circular in section and lined with concrete. In general, the greatest loads to come on the linings will be those from grouting the surrounding rock or from groundwater when the shafts and tunnels are empty. For tunnel linings the minimum thicknesses of concrete to the "A line" (within which no point of rock is permitted to project) are from 10 to 14 in., depending upon diameter and depth of tunnel. Minimum thicknesses to the "A line" of concrete linings are generally from 6 to 12 in., for construction shafts and from 8 to 14 in. for waterway shafts.

In computing the thickness of concrete lining, the effective thickness is taken to the "C line", that is, 5 in. outside the "A line". Analysis of many tunnel sections has shown that with current methods of excavation of rock tunnel there is a very small percentage of rock between these lines; also the specifications provide for the removal of any considerable projection of rock within the "C line" which might materially weaken the concrete lining.

Thicknesses to the "C line" have been computed by the Lamé formula for stress in a thick hollow cylinder, assuming the external load to be full groundwater head from the general elevation of the overlying ground and a compressive stress in the concrete of 2,000 lb. per sq.in. for concrete containing 2 barrels of cement per cu.yd. The limitations of this formula are recognized, but in view of the great uncertainties of the groundwater pressure which will actually come upon the lining, the highly irregular outer surface and thickness of the concrete instead of the assumed cylindrical surface and uniform thickness, and the unknown effect of adhesion of the concrete to

the rock, more refined analysis, such as consideration of Poisson's ratio, has not seemed warranted, especially as the same method of analysis has given satisfactory results in the many pressure tunnels previously built by the Board of Water Supply.

The thickness indicated by the Lamé formula, however, have not been precisely adhered to, certain arbitrary minimum thicknesses having been established for the upper parts of the shafts to take care of loads other than groundwater, and certain arbitrary maximum thickness adopted for the deepest parts of the shafts and tunnels where there is doubt as to whether full groundwater pressure from the surface of the ground will ever be realized. In the latter cases, the concrete will still not be stressed to rupture; if there is evidence during construction of probable excessive groundwater pressure, weepers can be left in the lining. The weep holes will not be provided with check valves if the groundwater head is high above the hydraulic gradient, but check valves will be used to prevent outward leakage if the groundwater head is below the hydraulic gradient.

Shaft linings and roof support

All shafts are lined with concrete as they are sunk, no other support either temporary or permanent being used. The length excavated before lining depends upon the quality and condition of the rock. In the best rock the contractors have been permitted to excavate as much as 100 ft., but no more, before placing the permanent concrete lining. In the poorest rock shafts have been excavated and lined in lengths as short as 8 ft.

In most of the shafts from seven to ten galvanized steel pipes from 1 to 6 in. in diameter have been built into the concrete linings to serve as high pressure air lines, pump discharge lines, to supply water to the drills and for other purposes, and as conduits for electric light, power, blasting, telephone and signal cables. On the completion of tunnel lining and grouting these service pipes will be capped or plugged and filled with concrete or grout.

This type of construction has resulted in a fireproof shaft and one from which water could be excluded by grouting the surrounding rock with the support of the concrete lining. It has also afforded complete protection to vital pipes and power, light and signal cables and left the interior of the shaft unobstructed by such pipes and cables and free and clear for the steel hoistways, safety ladders and large ventilating pipes required during tunnel construction.

In the tunnels each heading will generally be completely excavated before lining. Much of the rock requires rather prompt support, rarely because of the danger of extensive falls, but to protect men and equipment from blocks, slabs and spalls loosened by stresses in the rock on exposure to the air. For this support, following the practice on all the other pressure tunnels built by the Board of Water Supply during the past thirty years, steel wall plates, steel ribs, generally curved, and steel lagging are used. The wall plates are supported on timber posts, or, where the load is light, on 2-in. steel pins set in holes drilled into sound rock. Timber, other than in posts, is permitted to be used only sparingly, and it is required that all possible timber shall be removed before placing the concrete lining. A compressible cushion of timber, softened by saturation with water, between the concrete and the rock, would permit displacement and cracking of the concrete lining by the internal water pressure when the tunnel is in service.

Subject to general specifications the contractors have been permitted to submit detailed designs of steel roof support for approval, with the result that there are many variations in details. Heavy loads on the steel have been exceptional and dry packing, while provided for in the contracts, has been needed over a relatively small part of the steel. To the greatest possible extent all spaces outside the steel roof support will be filled with concrete integral with the tunnel arch. Spaces which cannot be so filled, including voids in dry packing, will be grouted. All possible timber as well as most of the steel lagging not supporting dry packing will be removed before concreting.

Where spalling only is anticipated and there is no probability of the loosening of large masses of rock a protective coating of gunite on the rock, generally about ½ in. thick, applied promptly after thorough scaling, is being extensively used with highly satisfactory results. Ordered or approved steel roof support, timber, dry packing and protective coatings are paid for at the several bid prices, separate from the price of excavation.

At several locations, limited shaft site areas and the proximity of dwellings or other important buildings or of railroads or important highways have precluded surface magazines of sufficient capacity to supply tunnel operations using several thousand pounds of dynamite a day. At such places underground magazines have been excavated from the tunnel, at the city's expense, at a safe distance from the shaft.

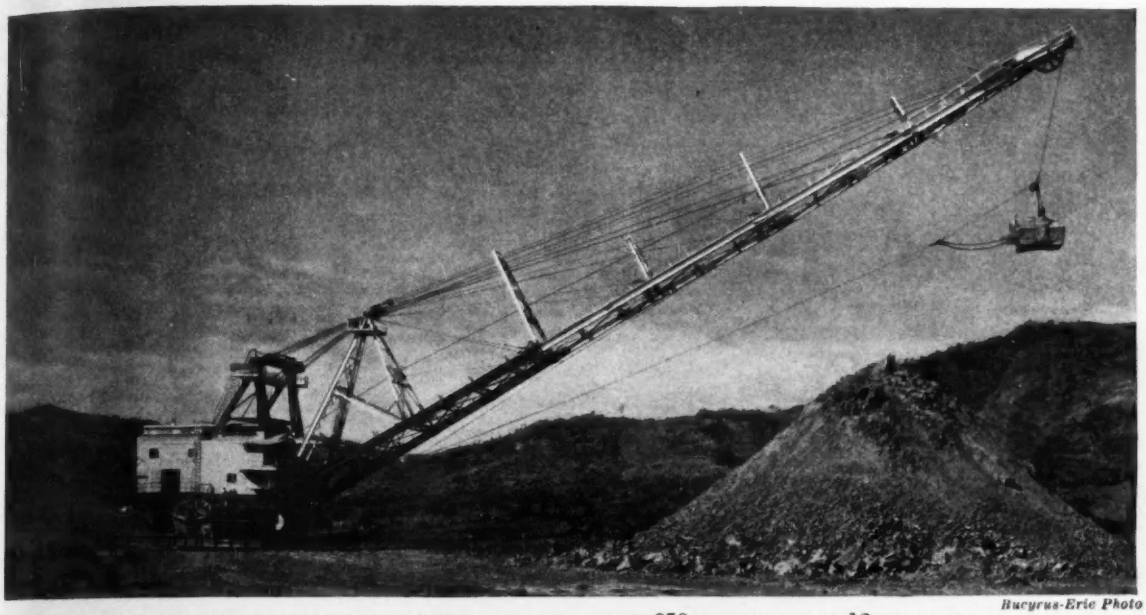
These magazines are similar to those used for the two delivery tunnels in the city previously built. They have separate compartments for opening dynamite, for storage of dynamite, and for primers. Furthermore, they are equipped with massive doors which will close automatically in case of an explosion and protect the tunnel from flying rock and gases, and are of such volume that the explosion of the entire permissible content of 3,000 lb. of dynamite will not generate destructive pressures.

All voids are grouted

For resisting the internal water pressure in the waterway shafts and tunnels reliance is placed upon the surrounding rock. Only in exceptional cases will either bar reinforcement or steel plate interlinings be used. So that the rock may resist this pressure without such movement as would crack the concrete linings, all voids outside the concrete linings, such as pockets over the tunnel arch which cannot be filled with concrete, will be grouted, as will be the seams, joints and other voids.

The Portland cement grout will be forced in under final pressures of from 300 to 1,000 lb. per sq.in., not only to consolidate and stabilize the rock but to shut off inward leakage when the shafts or tunnels are empty, and eliminate outward leakage when the aqueduct is in service. In addition to such final grouting, grout injections have been used to shut off water during both shaft sinking and tunnel driving, for which purpose pressures as high as 1,000 lb. per sq.in. have been used.

Other articles in the series are scheduled to appear soon.



Bucyrus-Erie Photo

FIG. I. MOBILE ELECTRIC DRAGLINE EXCAVATOR WITH 250-FT. BOOM AND 12-YD. BUCKET.

Electric Drive for Ordinary Jobs—V

Simple Hoists for Cable-Operated Scrapers

GEORGE H. HALL
Mechanical Engineer, Douglaston, N. Y.

Contents in Brief—Earth handling equipment which operates digging buckets or scrapers actuated by cable is distinguished by a power unit consisting of a single-motor drive of one or more cable winding drums. The chief distinction between the several forms, as draglines, slacklines, tautlines, etc., is in the cable system for handling the digging tool. Both wound rotor and squirrel cage motors are used.

CABLE EXCAVATORS occupy an outstanding position among earth-moving machines. They are familiar to contractors as derricks, dragline scrapers, slackline scrapers, tautline scrapers, dragline excavators and cableways. In all, with respect to electrification, every function of the machine is activated by a single motor drive, or, simply an electric hoist. On occasion a separate motor is used for one of the functions, as boom operation, but ordinarily the single motor drive performs all machine operations by means of one or more cable-winding drums.

In the usual construction, each drum is mounted loosely on a driving shaft and is provided with a friction clutch by which it is connected to, or disconnected from the driving shaft by the operation of a hand lever. Each drum is also provided with a friction band, controlled by a foot lever, by which lowering is accomplished by gravity pull on the load without the necessity of reversing the motor, which is constantly in operation in a single direction. The type of motor best suited to the drive of any particular machine depends upon the machine.

Derrick equipment simplest

As an excavator a derrick is limited to the operation of buckets of the grab type as clamshell or orange-peel buckets. In addition to the power unit, it consists of a mast and boom and two operating cables, one for raising the load and one for raising and lowering the boom. Derricks of small capacity may be powered by a squirrel cage motor having heavy-starting torque and low-starting-current characteristics but the most usual equipment is a wound rotor motor with drum controller and suitable resistance for slow-starting duty. As the motor is in continual operation, speed adjustment is not involved. The motor is usually started without load although both it and the squirrel cage should be capable of breaking out a load when it is applied to one of the drums before the motor is started. In this case the wound rotor motor is particularly effective and also it will speed up on light loads and slow down, with increased torque, when heavy loads are applied.

The drum controller may be provided with a bevel gear operating a rod extending along the side of the hoist to a point where it is within reach of the operator. Frequently, on large derricks, a small auxiliary drum carries the cable to swing the boom. A reversing controller must be used. In some hoists, the swing-

ing drum is provided with its individual motor of the low-starting-current type with a simple reversible starting switch, preferably of the magnetic type, to be controlled from a pushbutton station at the hoist proper.

Cable drag scrapers

In the simplest form of cable-operated drag scraper the bucket, riding on the ground, is pulled back and forth between the hoist and a tail pulley. Two cable motions are involved, one for pulling the loaded scraper along the ground and the other for returning it empty to the point of digging. The retracting speed, greater than the load-pulling speed, is arranged for by the relative diameters of the two cable drums or by the driving gears.

The wound rotor motor is admirably suited for this service due to its tendency to slow down under heavy load and to speed up when the load is light. This gives a slow but powerful pull on the load cable when the dirt is encountered and a somewhat higher speed after the scraper is loaded and simply rides along the ground to the discharge point. This characteristic is also of advantage when the scraper encounters an obstruction; this immediately causes the motor to slow down and the torque, or pull, at the same time to increase to overcome the obstacle.

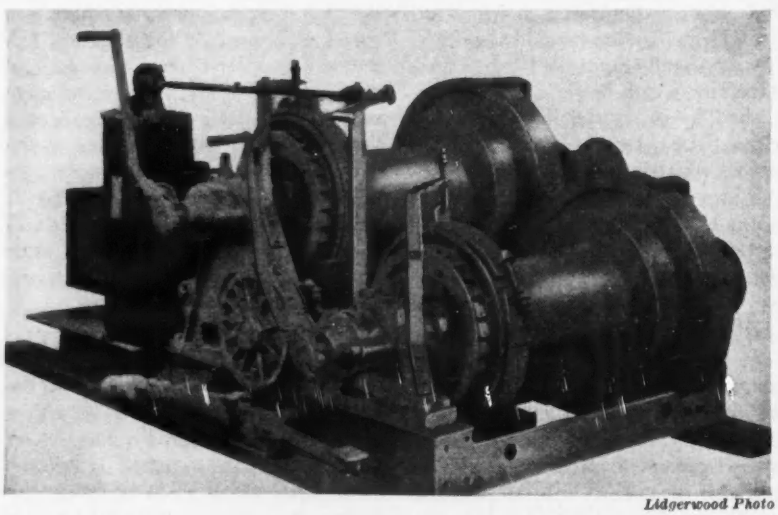
The drag, or load-handling, cable may lead directly from the drum but it is more often fed through a block at the head of a mast at some height above the hoist so that the pull on the scraper will be at an angle from the horizontal and thus relieve some of the friction on the scraper. The pull-back cable may also run to the mast pulley or it may run directly from the hoist to the pulley fastened to the post or a bridle at a point beyond that at which the digging is to begin.

For use in tunnels, where headroom is limited, there is a form known as a tugger hoist from which both the drag and the pull-back cables run directly from the drums. This hoist is of particularly compact construction, having the two drums carried side by side on a common shaft while the motor is mounted on the end of the hoist frame. The motor operates constantly and the loose drums are clutched alternately to the shaft by levers, which are at the back or side of the hoist. Such a hoist is usually equipped with a squirrel cage motor of the high-starting-torque type.

Dragline scrapers are often mounted on automotive tractors, the construction and operation of the draglines being similar to that of the fixed equipment. The drum unit which substitutes for the head tower is mounted on the tractor and the cables operate through a fixed tail block or bridle. A variation in this form of dragline is found in the boom dragline which uses no tail tower but the tail rope is carried through a block at the end of a long boom. Such equipment is in effect a combination of the dragline and the derrick. If it is electrically equipped, the power unit is driven by a single-speed motor, as in draglines and derricks, and the various movements, whether drag and pull back, boom hoisting and lowering, or boom swinging, are accomplished by mechanical control of the drums.

Ingersoll-Rand Photo

Fig. 3. For removing blasted rock in tunnels a special cable scraper-bucket excavator known as a tugger has been frequently used.

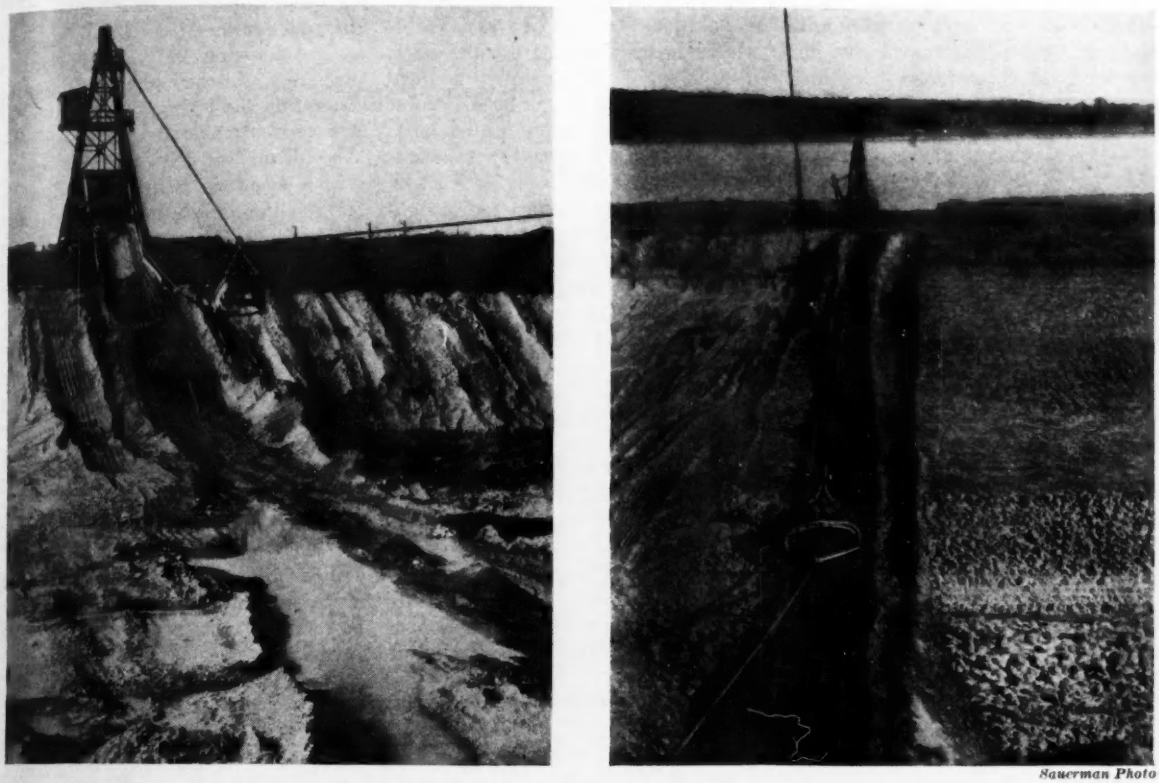


Lidgerwood Photo

Fig. 2. Two-drum electric hoist representative of the single-drive power unit used on cable hauled scraper-bucket excavators.

Slackline cable-riding scrapers

In slackline excavators, the bucket or scraper is drawn up to the point of delivery on a track cable. The two drums of the slackline hoist handle a drag cable and a track-tightening



Sauerman Photo

Fig. 4. Slackline cableway with traveling towers building a Mississippi River levee.

cable respectively. In operation, the bucket or scraper, after being discharged, is allowed to run back down the track cable by simply releasing the friction on the drum and permitting the weight of the bucket to overhaul the cable. When the bucket has reached a point above which the digging is to begin, the track cable is released permitting the bucket to drop to the earth. The bucket or scraper is then drawn at a low speed until it is filled when the tightening of the track cable raises it above the ground and provides a track over which it is pulled.

The actual speeds of these cables may vary in different installations but a good average is that of 200 ft. per min. for the bucket when digging and 600 ft. per min. when transporting the loaded bucket. The track-tightening cable has a speed of about 300 ft. per min.

Two methods of obtaining the speed changes demanded by the drag cable are in use. The first method employs a constant-speed motor and the speed changes are obtained by wholly mechanical means. The track-tightening cable of the hoist, in this case, is driven by friction clutch and gearing at a constant speed while the load drum is provided with two sets of gears and clutches so designed that a high or low speed may be imparted to the load cable. When the low-speed gears are in mesh the low speed of the cable is used for digging and as soon as this is accomplished the high-speed gears are engaged to impart the high speed desired for drawing the load up the track cable which has been tightened. Both drums, when lowering the empty bucket and when releasing the tension on the track cable are released from their shafts and allowed to coast and pay out their respective cables; too high a speed, which might cause the cables to overrun, is prevented by foot-operated friction brakes. When this method is employed, it is customary to use the wound rotor motor which runs at a constant speed and is started by a drum controller with starting resistance only. Squirrel cage motors of the high-starting-torque and low-starting-current type are also used.

With the second method both drums are driven from a common shaft and manipulation of the friction clutches is needed only when releasing or actuating the drums. The motor used in this method is of the squirrel cage, two-speed type having two sets of stator coils each suited to the desired pole grouping and consequently to the speed to be applied.

The advantage of the first method is that each drum can be geared for the particular speed or speeds at which it is to operate while with the second method the speed of both drums is simultaneously governed by the speed for which the motor is adjusted. On this account it often happens that the track-tightening cable, which must operate at slow speed, retards speeding up of the drag cable until the track cable is completely tightened and this means that for a considerable part of its travel the bucket is moving at the slow speed whereas, with mechanical speed changing, it is possible to speed up the bucket travel, while the truck cable is being set.

The use of a constant-speed motor requires less electrical manipulation but is accomplished with a motor which has collector rings and brushes which involve slightly more attention than the brushless squirrel cage motor. With the continued mechanical shifting of the gears more manual energy must be expended than with the two-speed motor in which the

speed changes are accomplished with magnetic control actuated by the movement of a master switch which requires the expenditure of but little physical energy. The first cost of the control for the single-speed motor will be less than that for the two-speed.

It should be kept in mind that if the slow-speed operation is large in proportion to the high-speed running, the two-speed motor will receive considerably less cooling, which may cause it to overheat.

For excavation projects extending for long distances, such as the excavation of canals, or the construction of levees, the slackline makes use of towers which may be moved along on rails as the work progresses. Such slackline scrapers are usually classed as tower excavators. The essential difference from the slacklines described above is the use of movable towers.

Tautlines employ a track cable which, in distinction from the slackline cable, is permanently mounted between a head tower and a tail tower and is stretched about horizontally. Upon this track runs the conveyor carriage which may be equipped with hoisting hook or buckets for straight conveying work or with automatic dumping skips, orangepeel or clamshell grabs for digging as well as for transporting. Tautlines are therefore suited to a broad field of construction work since the track cable may be extended over a wide span and they are employed for handling concrete, cut stone and all kinds of material for the construction of bridges, dams, filtration plants and projects of similar nature.

In operation, a conveying cable draws the carriage in and out to positions directly above the points of lifting or lowering while the raising or lowering of the load is accomplished by functioning of the hoisting cable.

The hoisting unit of the tautline has two clutched drums, that for operating the hoisting cable being of the conventional smooth-barrel type. The drum for the conveyor cable, which is endless, is spooled and, when not winding, holds the carriage in any desired position along the track. As the conveyor cable draws the load both in and out along the track, a reversible motor drive is employed. In hoisting, the full load of the material being lifted is applied ot the cable at starting from a standstill at which time slow speed and heavy torque is required. The above conditions, as related to both of the drums, indicates the use of the wound rotor motor with a reversible controller.

The following article on electric drive for ordinary jobs will consider motors and power control for cable excavators.

Supply Canal for Lower Rio Grande

Contents in Brief — Conference of engineers convened by American Boundary Commissioner proposes $60,000,000 canal and reservoir project to carry 3,000 cfs from a diversion at Rincon 168 miles to Brownsville to remedy threatened water shortages.

TO REMOVE THE THREAT of water failure that has been overhanging the irrigated area of the Lower Rio Grande Valley for some years because of increasing use of water on both the Mexican and American banks, a $60,000,000 diversion canal and reservoir project has been developed by a conference of engineers convened by the American Commissioner of the International Boundary Commission. The project is outlined in a report just made to the American Commissioner, and a bill has been introduced in Congress to authorize its construction (HR 9442, by Congressman West of Texas).

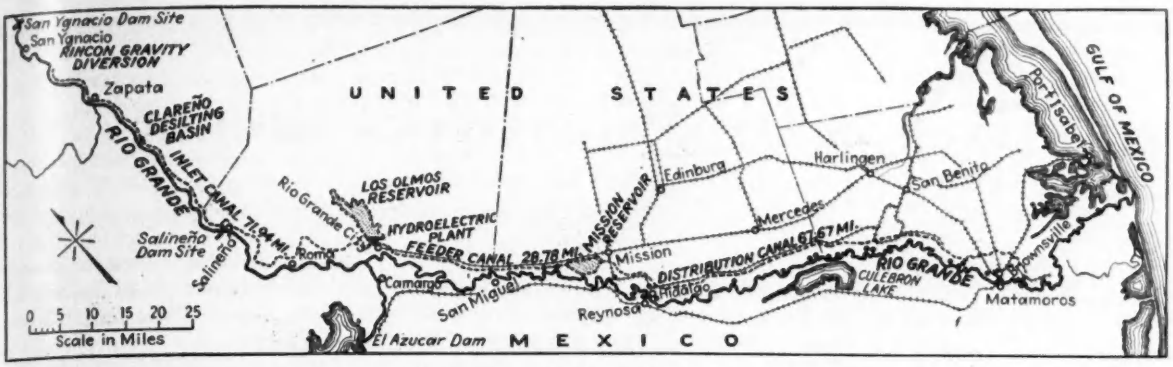
Farms and orchards totaling nearly 500,000 acres are under irrigation in the rich Rio Grande bottomland section of Texas. Water is supplied to the land by numerous pumping plants on the river banks which deliver to canals extending back into the irrigated land. The individual irrigation districts which operate these plants include a total irrigated area of 583,000 acres, although the total area of fertile land that could be supplied from the river were sufficient water available exceeds 2,000,000 acres. When the river bed at the pumping plant is dry, as has happened on a number of occasions during the past two or three years, irrigation must stop and crops and orchards are in danger of destruction.

The critical water-supply situation that has developed, especially since irrigation on the Mexican side began to increase, was described by W. W. DeBerard in "Border Warfare for Water" (*ENR*, Nov. 3, 1938, p. 555). Study of means of relieving the situation was taken up nearly two years ago under a PWA grant by the United States Section of the International Boundary Commission, and preliminary findings of the study were reported a year ago (*ENR*, April 13, 1939, p. 487). The present report represents the completion of the study.

Canal 169 mi. long

The main features of the project are shown on an adjoining map; they include a 72-mi. inlet canal of 3,000 cfs capacity diverting from the Rio Grande at Rincon, two balancing reservoirs at Los Olmos and Mission (315,000 and 90,000 acre-ft.), an 18,000-kva electric plant at Los Olmos reservoir, a 30-mi. feeder canal of 3,300 cfs capacity connecting the two reservoirs, and a 67-mi. distribution canal tapering from 3,500 cfs to 250 cfs extending along the river down to Brownsville to serve the canals of the irrigation districts.

At Rincon a rock barrier forms a natural reef or dam across the river with a deep pool above; the diversion heads in this pool and is protected on the bank by a dam and gates to guard the canal against flood rises, which may exceed 40 ft. With the two balancing reservoirs the direct diversion, without upstream storage reservoirs, will assure the valley an



Canal project to assure water supply to irrigated area of Lower Rio Grande Valley comprises diversion at Rincon, two reservoirs of 405,000 acre-ft. capacity, and a canal to Brownsville.

uninterrupted supply of 1,150,000 acre ft. per year, and with upstream carry-over storage a supply of 1,400,000 acre ft. The estimated benefits are $132,000,000. Its total cost exclusive of upstream storage is $59,643,000, and the credit against this sum for capitalized value of the energy produced at Los Olmos is $10,000,000, making the net cost $50,000,000.

Land and water supply conditions

At Roma, 225 mi. above tidewater, the Rio Grande emerges from the hills and irrigation along its banks begins; the delta proper extends south from Hidalgo and includes an area of 2,500 sq. mi. On the American side of the river, delta development on a large scale began in 1905 and more actively some 15 years later; on the Mexican side large-scale development began in 1937.

American lands in the Lower Valley now include citrus, vegetable and other tilled land totaling more than 400,000 acres, and contain a population of 225,000 and a dozen modern cities and towns, all dependent on Rio Grande water for domestic and industrial purposes. The area is served by 34 irrigation districts and private irigation systems including 861,000 acres (715,000 irrigable), of which 583,000 acres are equipped with irrigation facilities comprising 14 river pumping plants with lifts of 12 to 40 ft. and 3,300 miles of main canals and laterals. The total valuation of the area is placed at $202,000,000, of which $30,000,000 represents irrigation works; the annual crop exceeds $20,000,000.

Most of the pumping plants are 20 years old, and their operation is interrupted by both flood and low water. Shortages of supply have been experienced nearly every year for a long time past, even without important use of water on the Mexican side. The present development of farm areas in the Mexican delta, such as construction of the Retamal headgate in Mexico, a short distance above Culebron Lake, which can divert the entire low-water flow, presents critical prospects for the American irrigators.

Last year clearing and canal building was in active progress on the first unit (247,000 A.) of the Matamoros project, below Culebron Lake. Use of water on a large scale by the Mexican lands is scheduled to begin this year and next; nearly 10,000 settlers are already in the area. The present outlook is for 450,000 acres to be irrigated in the Mexican delta.

While the rainfall in the delta region averages 23 in. per year, minimum years with as little as 11 in. have been recorded, and summer irrigation is essential to all fruit and vegetable crops. At present only unregulated river flow is available, and this is subject to diversion by Mexico. Shortages in the low-water season are therefore inevitable.

The conference reported that "water shortages are becoming increasingly more severe and prolonged, and devastating droughts with attendant property and crop losses are foreseen unless work can be started soon and pushed to an early completion." Full remedy of the situation cannot be obtained until impounding reservoirs are built on the main river or principal tributaries; main river dams cannot be built, however, until a treaty is concluded with Mexico on construction and water division.

The present project will afford such improvement in supply conditions as can be obtained with unregulated flow, and will not be rendered obsolete by international planning for the use of the river water and for provision of carryover storage. Suggested sites for future international dams are at Salineño, Sullivan Springs (El Jardin site) and several others farther upstream. A storage reservoir on an American tributary, the Devil's River (Pafford Crossing site) was also studied and was found to have promise.

The conference concluded that in order to protect the development of the lower valley and pending treaty agreement with Mexico on carry-over storage and on division of water, "the water must be given a domestic status from the point of diversion in the Rio Grande to the point of use in the valley. This requires the substitution of a canal for the river as a carrier of water to the existing irrigation facilities." An additional advantage of the project, it says, is that it would eliminate pumping costs including the expense of maintaining pumping plants on the unstable banks of the Rio Grande, as well as the risk of crop losses through interruption of pumping by floods.

Construction of the project by the United States is proposed, the water users to repay the cost of the Los Olmos and Mission reservoirs and the annual cost of operation and maintenance of other features of the project except the power plant. No recommendation is made as to the agency that should handle the job.

Lawrence M. Lawson is American Commissioner of the International Boundary Commission, El Paso. The engineering conference included Alfred Tamm, R. J. Cummins, E. N. Noyes, Ben F. Williams, R. J. Tipton, C. M. Ainsworth, J. L. Burkholder, and J. L. Lytel, the last three representing the Boundary Commission.

Notes on the Waterworks Meeting

AMONG THE 40-odd papers presented at the technical sessions of the American Water Works Association meeting in Kansas City April 21-25, special interest was focussed on those which dealt with taste and odor control, pipe linings, and design features of several new waterworks installations.

About half of the papers are given here in abstract form. The selection has been made on the basis of widest appeal and general usefulness. For convenience of reference the abstracts are arranged in three categories—design and construction, waterworks management, and operation and maintenance.

Design and Construction

CEMENT LINING

Experience with the use of cement mortar lined water mains at Charleston, S. C., led the water department to seek for some practical method for the protection of mains in place after they had been cleaned. Eventually a contract was made with the Tate Pipe Linings, Inc., of Andover, Mass., for the experimental lining of 2½, 4, 6 and 8-in. pipe. (See *Jour.* A.W.W.A., Aug. 1935, p. 1,073 for a description of the Tate process.)

From a summary of tests made on sections of lined pipe in various parts of the system it was shown that the percentage of improvement on C values (based on nominal pipe diameter) was as high as 280. On one section of 8-in. pipe the value of C after cleaning and lining went up from 40 to 112.

The cost of the work amounted to one-fourth to one-half the cost of replacement of main, and varied, of course, with the kind of paving, number of services, hydrant and street crossing connections. On 4-in. mains the cost varied from 45 to 55¢ per ft. lined; on 6-in. sizes from 46 to 90¢ per ft.; and on 8-in. mains from $0.50 to $1.55 per ft.—JAMES E. GIBSON, *Manager and Engineer, Water Department, Charleston, S. C.*

STEEL PIPE PROTECTION

In the matter of interior and exterior protection of steel water pipe, there are certain well established principles which can can serve as a guide in the selection of pipe protection. The American Gas Association and the American Petroleum Institute have conducted independent and exhaustive field burial tests and the final disinterment of the latter's test samples is being made this summer.

However, their previous examinations of a number of samples of protected steel pipe have already established the following basic principles: (1) Protective coatings to be economically justifiable must have substantial thickness; (2) in general, the coal tar enamel coatings are more stable and less susceptible to absorption of water than asphalt coatings; (3) the use of asbestos shielding wrappers so greatly increases the service life of protective coatings that their use gives a return on the investment far in excess of their cost; and (4) no protective coating, however it is constituted, can give effective and durable protection unless it is properly applied to steel pipe surfaces that are in proper condition to receive them.

The selection of an interior protection for steel water lines should, in most cases, be made with the purpose of permanently maintaining high flow capacity. To get this permanence the lining selected should be as nonabsorbent as possible of water to which it will constantly be exposed, and it should be a lining of substantial thickness so that it will endure. Present-day thinking on material having these two qualities is that hot-applied coal tar enamels most nearly approach the ideal.—DEMING BRONSON, *vice-president, Hill, Hubbell & Co. Div., General Paint Corp., Cleveland, Ohio.*

FLEXIBLE STEEL PIPE

Experience has shown that flexible steel pipe under earth loading cannot be designed properly when the ordinary bending moment formula is used to determine pipe wall stress. Methods of stress analysis which apply to rigid wall pipe do not apply to flexible pipe.

For years after corrugated pipe had been put on the market, its amazing strength under high and low fills and under huge live loads puzzled many engineers. However, no stress determinations using the ordinary bending moment formula would account for anything except quick and complete failure. But these failures did not occur. Obviously, the theory of strength calculations using the bending moment formula which worked so well with rigid wall pipe, but consistently indicated failure for flexible pipe when no failure occurred, was being erroneously applied in the case of flexible pipe. Flexible steel pipe acts in obedience to other factors than those accounted for by the bending moment formula.

Tests show that the load sustained on the rigid pipe (concrete, cast iron, vitrified clay) tends to concentrate at top and bottom. Flexible pipe, on the other hand, deflects slightly and distributes the load uniformly around its circumference. The unit pressures at top and bottom of flexible pipe are as little in some cases as one-third of that on a rigid pipe under identical loading conditions.

Although the maximum load-carrying capacity of flexible pipe depends to some extent on the wall thickness, the pipe is usually able to make full use of the load-carrying ability of the earth surrounding it. Since it may change without failure, it possesses the ability to transfer the vertical load into a horizontal thrust and thus supports the vertical load in a manner somewhat similar to the action

of an arch. If the wall itself were rigid, this movement could not occur without wall fracture. It follows that the rigid pipe must carry the whole load itself or break but the flexible pipe divides the load with the earth enclosing it. Therein lies the inherent difference between rigid and flexible behavior and the explanation why the bending moment formula applies to the analysis of rigid pipe but not to flexible pipe.—R. E. BARNARD, *advisory engineer, The American Rolling Mill Co., Middletown, Ohio.*

LANSING'S NEW PLANT

Many novel features distinguish the design of the Lansing, Mich., 30-mgd water softening and filtration plant, which went into operation in December, 1939. Air conditioning devices have been installed to control condensation because of the large volume of water continually flowing through the plant, and sufficient radiation has been provided so that an inside temperature of 70 deg. can be maintained.

In the chemical feed room heating elements and fans are used to assure thorough distribution of warm air against the walls and surface of equipment. The pump room and pipe gallery are insulated by weather-stripped doors so that condensation may be eliminated by lowering the humidity. This latter function is accomplished by means of a chemical dehydrating device and a circulating air fan of 500 cu. ft. per min.; about 5 lb. of moisture can be removed per hour with this equipment.

Among other special features in the plant are the pneumatic chemical handling facilities for lime, soda ash and alum; the wide use of air pressure controls rather than hydraulic or electrical means; piping arrangements which permit the reclaiming of filter washwater; and the centralization of sampling facilities.

Sampling and testing have been simplified by running ⅜-in. copper tubing to 19 different points in the plant leading to a common sampling table. This table is provided with 3 illuminated sampling glasses for drawing, wasting or holding a quart sample by means of an aspirator connection. An air supply line permits the cleaning of sample lines. The sampling room has no window and is lighted by fluorescent lights only so that uniform results may be obtained with colorimetric indicators.

The plant building, which is of monolithic concrete construction, was built with the aid of WPA labor. Alvord, Burdick and Howson were the engineering consultants.—CLAUD R. ERICKSON, *mechanical engineer, Board of Water and Electric Light Commissioners, Lansing, Mich.*

WICHITA PIPELINE

The design of the cast iron pipe used in the 28-mile pipeline being installed at Wichita, Kan., was based on the new principles and methods of design developed by Sectional Committee A21 of the American Standards Association. (Part I, *Manual for the Computation of Strength and Thickness of Cast Iron Pipe.*)

This new method enables the engineer to design and, through its acceptance by the pipe manufacturers, to obtain pipe of an adequate, but not excessive, thickness necessary to withstand any condition of internal pressure and external loading, and in addition to take advantage of any available strength and quality of iron. Instead of being restricted to the few standard classifications available under the older standard pipe specifications, the engineer can now design pipe of as many thicknesses as may be required to meet varying conditions of pressure and external loads.

The old methods of pipe classification, being based on internal working pressure, required that all pipe within the class pressure limits be of the thickness necessary for the maximum pressure condition encountered even though most of the line might be subjected to a much lower pressure. The older methods also assumed external loadings which were based on ordinary distribution system service and which were not only excessive for shallow cross-country transmission lines but entirely inadequate for large-diameter pipe subjected to low internal pressure and heavy superimposed loads.

A number of special pipe classifications were used in specifying and designing the Wichita type, being based on both internal working pressures and external loadings. The pipe was classified for internal working pressures as Class 50, Class 75, and Class 100, the figure in each case representing the water working pressure of the pipe in lb. per sq. in. The pipe was classified for external dead loads as "Standard," Class 3.5 and Class 5.0. The "standard" class, which carried no classification symbol, was used for a nominal depth of cover of 2.5 ft. or less. The figures in the other two classes represent the nominal depth in feet of the earth cover over the pipe.—R. E. LAWRENCE, *Black & Veatch, consulting engineers, Kansas City, Mo.*

KANSAS CITY PUMPING STATION

A desire to use the most modern equipment to meet unusual operating problems resulted in a design for a new pumping station for Kansas City, Kans., in which many unique features are incorporated. The station has an ultimate capacity of 75 mgd and is the high lift unit that supplies the distribution system.

One of the outstanding features is the use of a hydraulic coupling to vary the speed of a synchronized motor driven centrifugal pump. This arrangement offers not only great operating flexibility but also provides power factor correction of considerable value to the electrical system. The hydraulic coupling is designed for high duty and is provided with oil pump and motor for forced bearing lubrication, reversing pump and motor for speed control, oil reservoir and oil cooler. This type of coupling was introduced in England in 1930 and brought to this country two years later. It has been widely used for forced and induced fan drives in boiler plants but is new to the waterworks field.

There are two radially vaned members that make up the main rotating parts of the hydraulic coupling. The primary member or impeller is mounted on the driving shaft, and the secondary member or runner is mounted on the driven shaft. These members actually are separated by about ¼ inch; they have straight radial blades and cast integrally with these blades there is a core or guide ring of semi-circular section with one-half in the impeller and one-half in the runner. The oil being forced by the impeller through the runner causes it to rotate or drags it around in the same direction it rotates. If the space is filled with oil the slip is only 2 or 3 per cent but if the amount of oil is reduced the slippage increases until with no oil at all and only air to act as the dragging medium the speed will drop to about 20 per cent.—C. S. TIMANUS and R. L. BALDWIN, *Burns & McDonnell Engineering Co., Kansas City, Mo.*

Operation and Maintenance

BREAK-POINT CHLORINATION

Practical experiences with break-point chlorination (*ENR*, Apr. 11, 1940, p. 521) over the entire country indicate that the process is extremely valuable for the control of tastes and odors. Furthermore, these experiences reaffirm the earlier ideas regarding the value of break-point chlorination for the production of a water more nearly free from all gas-forming bacteria than has heretofore been possible. Color improvement, coagulation economies and possible removal of bacterial food are also indicated.

The amount of chlorine necessary to achieve these results in the majority of cases has not been excessive for the average dose has seldom been more than 5 ppm. However, in a few isolated cases and for limited periods of time, applications as great as 35 ppm have been used. Extreme doses such as used for a few days in February, 1940, at Ottumwa, Iowa (110 ppm) are not usual and may never again be duplicated.

Odors of phenolic, algal and decomposition origin have on a plant scale yielded to break-point chlorination. These results have been obtained in some instances by the addition of chlorine alone; in others by a combination of chlorine and activated carbon, while in a few instances dechlorination with sulphur dioxide, sodium bisulphite, etc., has been necessary.

In general the treatment of waters to the break-point will not appreciably change the pH of the water. It is only in the extreme cases where the water contains little alkalinity that this phase of the treatment must be watched.—A. E. GRIFFIN, *sanitary engineer, Wallace & Tiernan Co., Inc., Newark, N. J.*

IRON AND SULPHUR ORGANISMS

Iron and sulphur groups of bacterial organisms found in domestic water supplies, and the odors and tastes produced by them, can be successively controlled by superchlorination and dechlorination. Experience at 7 plants of the Southern California Water Co. indicated that all odors and tastes appearing in well waters were produced by oxidizable compounds. Thus, if oxidation were carried to completion, these odors and tastes would cease to exist, and following superchlorination it would be necessary to remove only the excess chlorine to obtain a water both odorless and tasteless.

In addition to activated carbon, which acts as an adsorptive agent, there are several chemicals which react with chlorine to produce a tasteless product. The choice of the proper agent for dechlorination rests, then, with economical considerations, and the physical conditions of the plant. In plant practice our experience has been limited to activated carbon and sulphur dioxide. There are advantages and limitations in the use of each agent.

Activated carbon has one advantage which none of the other agents possess. If there is a slight failure of the chlorination equipment, and superchlorination has not been reached, the carbon will remove certain of the odors and tastes. Too much reliance upon this, however, leads to the failure of the carbon, and to the accumulation of organic matter within and around the carbon granules.

Sulphur dioxide is economically fed only through constant-rate feed machines, and its use is limited to points of injection at low pressures such as the suction side of booster pumps or open channels. Another objection to sulphur dioxide is that feed machines and sulphur dioxide cylinders must be kept in rooms where the temperature is thermostatically controlled.

When dechlorination is by chemical reaction, the required dosage is relatively easy to determine. For granular activated carbon, however, the problem is somewhat different. At one plant the filter capacity for the reduction of odors and tastes was based on one cubic foot of carbon for each gallon per minute of flow. For dechlorination this capacity may be safely increased to 1.5 or 2 gpm per cu. ft. There is as yet no established "law" but at such a rate the filters have been operating satisfactorily for over four years. For short periods higher rates have been used, but we have assumed that a rate of 2 gpm per cu. ft. of carbon should not be exceeded. This assumption remains to be proven.—L. J. ALEXANDER, *assistant engineer, Southern California Water Co., Los Angeles, Calif.*

CORROSION CONTROL

At Fairhaven, Mass., the ground-water supply from 30 driven wells was very corrosive in its action on service pipe and trouble was experienced with red water in dead ends. The water contained an average of 30 ppm in carbon dioxide and had a low pH value of 5.4.

Because studies showed that the addition of the usual lime or soda ash would reduce corrosion but slightly and would increase the deposition and accumulation of iron hydroxide in the system with the resulting red water troubles, it was decided to recommend the use of sodium hexametaphosphate, sold under the trade name of Calgon. This chemical has been used for about three years to prevent precipitation of calcium carbonate in distribution systems supplied with softened water.

Following the promising results of experiments, arrangements were made to apply 1 ppm of Calgon to the town water. This was applied to the suction main where it entered the sand catcher at the pumping station. The first effect of treatment was purgative. Accumulated iron oxide sloughed off the mains and red water became of frequent occurrence at dead ends. Conditions were controlled by careful operation until this effect ceased to be important.

Before adding sodium hexametaphosphate, a set of samples showed 0.40 ppm of iron in the well water, 0.08 ppm in the center of town, and 0.95 ppm in the dead ends. After six weeks, the amounts of iron increased to 0.60, 0.27 and 16.0 ppm at these respective points. Shortly afterwards, conditions began to improve. The amounts of iron gradually decreased to 0.11, 0.07 and 0.10 ppm, respectively.

To explain the action is difficult. The best explanation is offered by Langmuir, namely, that a film one molecule thick is formed on the metal and inhibits corrosion. It may be true, also, that the effort required to place the film loosens the accumulated ferric hydrate. It is true that a recent trial with a soft surface water of low color exhibited the same purgative effect on old deposits.

While the theoretical explanation is difficult, the results show that after eight months of operation, the iron content in the sample from the worst dead end has been reduced from 0.95 to 0.09 ppm, or 91 per cent, while

the color has been reduced from 29 to 5, or 83 per cent.—H. T. GIDLEY and ROBERT SPURR WESTON, respectively, *superintendent, Fairhaven Water Co. and consulting engineer, Boston, Mass.*

MODERN HYPOCHLORITES

Modern calcium hypochlorite is a dry, white practically dustless granular material. The grain size is such that practically all will pass a 20-mesh screen. It flows readily in the dry form and may be handled easily in the average dry feeder. It shows no tendency to cake under ordinary conditions. However, if exposed to very humid conditions it tends to form a superficial solution on the granular surface.

The granular product is really an improvement in calcium hypochlorites developed to eliminate the dust and otherwise consequent unpleasantness experienced in handling and applying the earlier white powdering substance.

Chloride of lime, erroneously called calcium hypochlorite in the past, was a variable composition and extremely unstable. True calcium hypochlorite is of constant composition and is extremely dependable in stability and it carries twice as much available chlorine.

Calcium hypochlorite contains 70-75 per cent available chlorine. In storage at 86 deg. F. for a period of a year the loss of available chlorine will not be more than 10 per cent of that originally present. Compared with compounds previously available such as chloride of lime, such stability is phenomenal.—C. LOGAN & W. L. SAVELL, *technical representative and manager technical division, respectively, Mathieson Alkali Works, Inc., New York, N. Y.*

Waterworks Management

DEFICIENCIES IN MANAGEMENT

An analysis of waterworks management and operation reveal deficiencies which must be eliminated in order that standards may be raised. Among the principal shortcomings there may be listed the following:

Appraisals — Operating expenses cannot intelligently be determined without knowing the value of the property. A report on the value, age, condition, and efficiency of the various departments of the existing system should be made at least every ten years. To illustrate the relative reproduction value of waterworks properties from year to year: If 1913 values are used as 100, the relative reproduction value of the same property in 1919 would be 250, by 1932 it would be 175, and in 1928 it would be 160. The reproduction value of waterworks fluctuates from year to year, and should be accurately known by the manager or superintendent and then used in determining the operating cost.

Board Management—As a general rule the most satisfactory and economical operation of a municipally-owned water property can be obtained through the management by a utility board (3 to 5 members). These boards are generally elected or appointed for a term of office greater than that for other classes of city officials, thereby insuring a greater consistency and continuity of policy. With this longer term of office, these utility boards are freer from political control and, for that reason, are more likely to attract to their membership the more capable business men of a community.

Water Rates—Many of our waterworks properties are being operated on rate schedules that need revision and adjustment. An astounding variation in rates charged for water is found throughout the country. For example: The average charge per 100 cu.ft. of metered water in 11 of the largest cities varies from 5.1¢ in Chicago to 25.8¢ in San Francisco. Cleveland has a rate twice as high as Chicago, yet both use a lake supply. Why Los Angeles should have a rate less than one-half the rate of San Francisco, where both cities use long-distance supplies, is difficult to explain. Why St. Louis should have a rate one-half that of Pittsburgh, both using river supplies with purification plants, is equally difficult to understand. These great variations in rate structures exist in many cities. In some cases a difference would be required because of different methods of operation and financing. However, in many cases rate schedules have been adopted without proper and adequate study of cost factors.

Political Management — Comparison of the number of employees in every 100,000 population usually reflects the degree of efficiency of management. A recent study of seventeen cities, utilizing reliable information, showed a remarkable range in the number of employees per 100,000 population, varying from 58 to 192. While some variation is expected, nevertheless a variation of over 3 to 1 does not appear justified. —R. E. MCDONNELL, *Burns & McDonnell Engineering Co., Kansas City, Mo.*

LAW AND WATER SUPPLY

It is well-established principle of law that the operation of public waterworks by a municipal corporation, as well as by a private corporation, is a proprietary function; and that the water authority is responsible for damages in the event that neglect is proven. In most of the states it must be established that the municipality or private company did something that it ought not to have done, or neglected to do something that it should have done.

The argument that the operation of waterworks is vital to maintaining sanitary and healthful conditions in a community and is therefore a governmental function, has failed to relieve the water authority from responsibility. The argument that the operation of waterworks is in part for purposes of fire protection and is therefore a government function, has failed also to shift the burden of responsibility, except where the damage claimed clearly resulted from the service of fire-protection service, apart from that of water service.

Damage may result from:

a. Leakage from the distribution system
b. Furnishing water of quality injurious to health
c. Furnishing water of quality injurious to industrial processes, goods, etc.
d. Structural defects on the system
e. Lack of pressure or lack of water
f. Methods of construction contrary to generally accepted methods of procedure
g. Careless work during construction
h. Negligence in operating and maintaining waterworks
i. Hazardous conditions on user's premises

Negligence, if proven, on the part of an employee or agent makes the municipal corporation as well as the private corporation liable for damages.—FRANK A. MARSTON, *partner, Metcalf & Eddy, Boston, Mass.*

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

USES FOR SLUDGE—Based upon the *Inventory of Sewage Disposal Facilities* (*ENR*, Jan. 19, 1939) it is conservatively estimated that the amount of sewage sludge produced at treatment plants in this country is between 1,500,000 and 1,800,000 tons of dry solids a year and that the recoverable quantities are between 600,000 and 800,000 tons. Whitehead (*The Surveyor*, Nov. 24, 1939) states that after allowing for the portion discharged at sea, the available sludge at inland sewage disposal works in Great Britain is equal to 750,000 tons of dry solid matter per year. He believes that field and laboratory tests carried out by responsible agricultural authorities, directed to supply information as to the fertilizer value of sewage sludge in relation to different kind of soils and crops, would do much to establish confidence in the use of this material, and the creation of a greater demand would encourage the development of better methods of sludge treatment.

In this country a few modest experiments have been conducted on the basis of fertilizing value, but no extensive experiments have been made to determine the fertility as well as the fertilizing value of the sludge. The large amounts of plant food and soil fertility values of the sludge now practically wasted would seem to warrant properly conducted experiments of sufficient duration and extent.

INFANTILE PARALYSIS—During the last ten years there were reported to the State Department of Health from the 64 parishes of Louisiana 676 cases of poliomyelitis (infantile paralysis). Intensive studies of all cases made by Casey and Aymond (*Science*, Jan. 5, 1940) showed that the incidence in rural and small urban communities was about the same as in the two large cities. However, smaller incorporated communities had a very much higher rate. The only factor which could be correlated was the presence of water supply systems and absence of an adequate sewage disposal system in the small towns. The 64 incorporated communities without water supply or sewerage system had 39.7 cases per 100,000 inhabitants or about the same as rural (32.1) and larger towns (30.6). The 27 communities with both water supply and sewerage systems had a rate of 26.6 cases per 100,000, while the 87 communities with water supply but without sewerage systems had a rate of 83.6 cases per 100,000. The highest rates of poliomyelitis in communities with water and no sewerage systems were found in towns with an average daily water consumption from 50 to 89 gal. per capita. Where water consumption was above 90 gal. per capita the rate again dropped to 39 cases per 100,000 or essentially the same as in rural-urban areas. The authors suggest the possibility that the poliomyelitis epidemics in the past few decades may have been influenced by the growing tendency of the communities to carry away human waste with water but without adequate provision for treatment.

Attempts to detect the dreaded infantile paralysis virus in sewage have been made in the Yale Medical School by Paul, Frask and Gard (*Journal of Bacteriology*, 39, 63, 1940). The method of detection consisted in the intraperitoneal inoculation of monkeys with various quantities of sewage treated with ether and obtained from 3 urban and 2 rural communities with epidemics of poliomyelitis. Positive results were obtained with four samples of sewage from two cities. One strain of the virus from each city was tested in rabbits, guinea pigs and mice and produced no characteristic lesions in the brains or cords of these animals.

The virus has been discovered in the intestinal discharges of patients, but also in discharges of healthy persons who did not have infantile paralysis, but who had been in contact with patients, indicating that the disease is spread by contact. If it is a contact disease spread like diphtheria and not a waterborne disease, the chances for spreading through pollution are not great, unless direct contact is had with the discharges. To date no published information or studies have come to the writer's attention to show what effect, if any, sewage treatment processes have on the destruction or disappearance of the virus. It is conceivable that certain biological or chemical processes may readily destroy the virus, although the mode of destruction may be different than for pathogenic organisms.

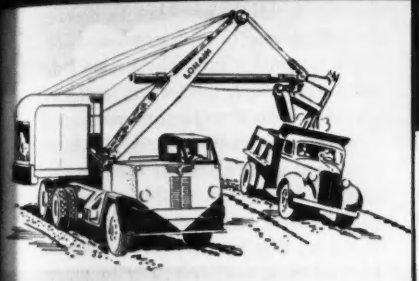
WASTE RECLAMATION—The slogan "There is wealth in the refuse cans of Great Britain" occurs almost daily in the press of England. The Ministry of Supply has set up a salvage department which has indicated the various classes of material fit for recovery. They include soap, metal, rags, bones, oil, paper, garbage, industrial wastes (particularly organic wastes), sewage sludge, etc. The yield of refuse is about 10 million tons per annum, but only about 1.5 million tons are mechanically separated through some 70 plants. These plants have proved to be so successful that two years ago the German municipalities were advised to follow the example. Controlled tipping takes care of about 5,000,000 tons of refuse per year.

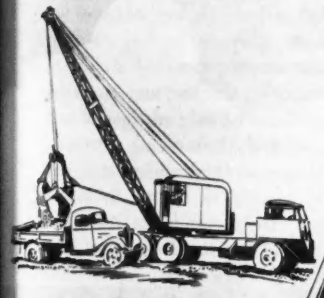
In the refuse there are about 15,000 to 20,000, tons of bones every year and since England is one of the biggest glue-producing countries in the world and bone importation has dropped seriously, this material especially is needed. The Ministry of Agriculture is particularly anxious to salvage garbage for hog feeding. The composition of house refuse in England according to Moss (*The Surveyor*, Dec. 15, 1939) is in percentages as follows:

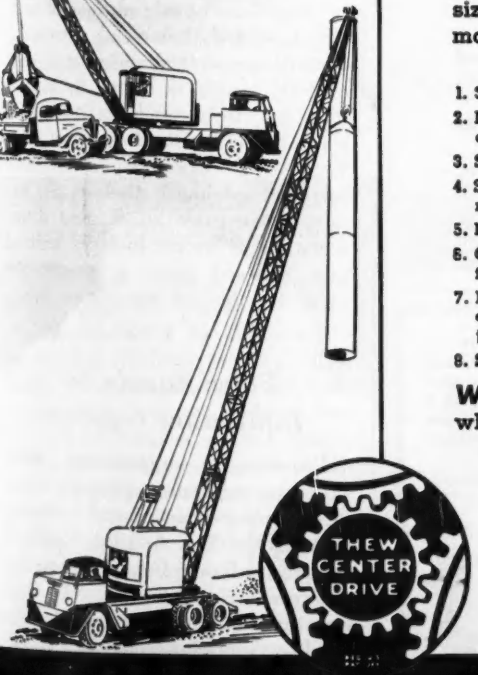
Dust	40–50
Cinders	10–24
Ferrous metals	1.0–3.5
Non ferrous metals	0.2–1.0
Glass	0.5–2.5
Bones	0.3–0.9
Paper	1–10
Rags	0.5–1.5
Tailings	20–30

The waste paper has increased greatly during recent years amounting to some 3 million tons, while tin cans collected amount to 30,000 tons. The cinders contain coal valued at $5,000,000; London alone wastes some 320,000 tons of coal annually.

MEET THE MOTO-CRANE!







SOMETHING NEW ON WHEELS

WHAT IS IT? First, let's clear the decks by stating that the Moto-Crane is *not* a truck crane. It's new and different in that it offers a complete, integral unit—of crane and mounting—with a mounting which from hub caps to outriggers is designed exclusively as a Crane Carrier. In other words, the Moto-Crane offers you a crane and carrier as one complete package — built by one manufacturer and covered by one standard warranty.

WHAT ARE ITS ADVANTAGES? The Moto-Crane is offered in 5 sizes ranging from light weight to heavy-duty, big-capacity units. All models offer the following advantages —

CRANE CARRIER

1. 3 axle mounting supported on 10 rubber tires.
2. Mounting is built of standard parts available all over the country.
3. Shorter wheelbase for better maneuvering.
4. Special chassis frame design eliminates reinforcing.
5. 10 speeds forward and 2 reverse.
6. Offset cab permits carrying boom in lower traveling position over front end.
7. Rocker arm rear end replaces springs—gives flexibility for road travel—rigidity for operation.
8. Space for groundman, tackle and rigging.

CRANE TURNTABLE

1. Simplified Center Drive direct-to-the-point power application.
2. Balanced to provide the greatest capacities per pound of weight.
3. Steel erector's precision boom hoist, with power control of boom lowering.
4. Pin-connected boom with center sections and straight or gooseneck tips.
5. Cab type tagline which functions efficiently at all boom angles.
6. Winch Head and Third Drum attachments.
7. Convertible to Dragline, Clamshell, Shovel, Backdigger.

WHO MAKES IT? The Moto-Crane is the product of the manufacturer who not only pioneered the first truck crane but developed it step by step to its present day efficiency and acceptance. Universal-Lorain has built more truck cranes than all others combined. The Moto-Crane is no "off-the-cuff" development. It's the outgrowth of 22 years' experience in this specialized field. Complete information on the Moto-Crane is available on request.

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ABSTRACTS AND NOTES

Pipe Protection Tests At Los Angeles

A trial of cathodic pipe protection on the 36-in. riveted steel water main of the Pico trunk line, to prevent further leaks due to soil corrosion on 3,000 ft. of pipe, is noted in the report of the Board of Water and Power Commissioners, Los Angeles, for the year ending June 30, 1939. The rate of leaks had increased during the past two years, causing considerable expense for maintenance, as well as inconvenience to traffic and business. Preliminary tests were made with a temporary anode and an electric welding machine to observe the effect on the pipe when under cathodic protection. These tests indicated that such protection could be applied, even though the complicated network of underground structures presented difficulties in their insulation so that the cathodic current would not be injurious to other structures in the vicinity of the anode. The selenium cell rectifier to supply the direct current was placed in a vault, and the permanent anode used for dissipation of the current was laid in an alley.

In the development of the corrosion test cell, aerobic and anaerobic cell exposures of thin sections of cast-iron, steel and alloy metals give some quantitative indication of coil corrosivity, which is useful in testing soils for their tendency to cause graphitic corrosion of cast iron pipe. Microscopic examination of cell-corroded specimens discloses the nature of corrosive attack, and determination of weight loss per unit of area exposed gives a quantitative value for the soil corrosivity index.

• • •

Water Supply for Infiltration Galleries

Providing a supplemental water supply to infiltration galleries is one of the improvements noted in the report of the Los Angeles Board of Water and Power Commissioners for the year ending June 30, 1939. Construction of the new river channel by the Los Angeles County Flood Control District in the neighborhood of the high gravity collecting works de-

creased the natural output of the infiltration galleries at this point by approximately 50 per cent, due to the general lowering of the channel and to the fact that a large amount of the shallow gallery was cut off by the work done on the channel previous to the flood of March, 1938. To remedy this situation, the district constructed a spreading ground of 35 acres on the west side of the river and over the galleries, and a connection with the river channel for conveying water to this spreading ground. The connection has headgates in the wall of the channel.

In the concrete structure of the channel, provision was made for the support of a removable timber dam 4½ ft. high to raise the river level sufficiently to cause water to flow to the spreading ground.

When water was thus supplied, the output of the galleries was increased from 14 to 25 cfs. Since it will be necessary to remove the dam for each rainy season, provision for maintaining the flow to the spreading ground was effected by installing a pump of 30 cfs capacity in the deep gallery shaft. This pump is of the vertical, propeller type, and the 30-in. pump column constitutes the rising leg of a siphon, the drop leg of which has a length of 16 ft. and produces a vacuum of 15 in. of mercury. The installation was made in this way to avoid the necessity of deep rock excavation adjacent to the shaft. It is stated that the installation operates very satisfactorily.

. . .

Sewerage in South Dakota Studied by Board

A survey of sewerage systems and sewage treatment plants in South Dakota, conducted by the sanitary engineering division of the State Board of Health, presents the following results, as reported in *The Clarifier*, official bulletin of the Board. Of the 300 incorporated municipalities in the state, 104 have sewerage systems. The population of these 104 municipalities is 231,528, or 80 per cent of the total urban population (289,751). Of the 104 cities with sewers 31 have no treatment facilities, 36 have primary treatment (sedimentation), and 37 have complete treatment (oxidation).

Ease AND CELERITY

Simple in design and rugged in construction the Model 375 AMERICAN GOPHER is Speedy, Extremely Versatile and handles with the Ease and Celerity of a 1940 automobile. The AMERICAN Improved Hook Roller System insures perfect stability and smooth rotation at all speeds. One of the busiest things in Minneapolis is Carl Bolander's Model 375 AMERICAN GOPHER. One of its recent jobs was excavating for a new building at the University of Minnesota: down in the hole, with a 180 degree swing and a 15-foot lift it loaded 800 yards in 8 hours, making three moves to different parts of the excavation during the day.

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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

FLOOD WALL
WEST VIRGINIA

OWNER: U. S. Engineer Office, Huntington, W. Va.; Lt. Col. J. D. Arthur, Jr., district engineer.

PROJECT: Construction of reinforced concrete walls, earth levees and gates, and appurtenant structures along left descending bank of the Ohio River, (Section 1, West End) in the city of Huntington, W. Va. Extends from short distance below 3rd St. to point below Devon Road, thence back to high ground at C. & O. RR. tracks.

CONDITIONS: Contractor to furnish all materials and complete project in 570 calendar days. Rail, water and highway transportation facilities available. Wage rates are: skilled labor, 85c. to $1.25 per hr.; semi-skilled, 60 to 85c.; and common labor, 45c. per hr.

BIDS: Six bids were opened March 21, ranging from contract low of $606,102 to $797,176.

LOW BIDDERS:

1. R. B. Potashnick, Cape Girardeau, Mo..... $606,102
2. LaCrosse Dredging Corp. and United Constr. Co., Winona, Minn..... 650,183
3. American Aggregates, Greenville, Ohio, and Myers & Goen, Salem, Ind..... 686,402

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Excavation, common	150,000 c. y.	$0.25	$0.17	$0.33
2. Excavation, structure	10,000 c. y.	.80	.60	.80
3. Levee embankment, pervious	835,000 c. y.	.285	.32	.38
4. Levee embankment, impervious	225,000 c. y.	.25	.27	.30
5. Additional rolling	20,000 sq.	.025	.05	.01
6. Fill, impervious	23,000 c. y.	.50	.78	.30
7. Fill, sand and gravel	600 c. y.	2.00	3.81	2.00
8. Gravel road surfacing	1,700 s. y.	.60	.82	1.00
9. Riprap	12,000 c. y.	5.00	4.00	4.40
10. Rock paving in gutters	250 s. y.	3.00	3.25	4.00
11. Topsoil	42,000 c. y.	.30	.30	.30
12. Seeding	52 ac.	125.00	250.00	150.00
13. Honeysuckle	57 M	160.00	140.00	80.00
14. Concrete, 5 bag mix	7,200 c. y.	14.00	16.44	12.80
15. Concrete, 6 bag mix	125 c. y.	18.00	25.00	15.00
16. Steel reinforcing	960,000 lb.	.04	.04	.04
17. Structural aluminum	8,100 lb.	1.00	.91	.75
18. Structural steel	19,500 lb.	.11	.16	.10
19. Steel bolts	600 lb.	.15	.40	.20
20. Bolts, corrosion resisting	1,050 lb.	1.20	1.30	1.30
21. Steel castings	4,600 lb.	.25	.41	.30
22. Forgings, steel and wr. iron	6,600 lb.	.12	.30	.20
23. Copper	6,400 lb.	.35	.52	.50
24. Paving brick	180 s. y.	3.50	3.30	3.00
25. Creosoted timber	19 Mbm	120.00	130.28	120.00
26. Timber piling	60 l. f.	1.50	.86	10.00
27. 8-in. pipe, perforated	560 l. f.	.90	.97	1.56
28. 10-in. pipe, perforated	370 l. f.	1.00	1.23	1.70
29. 12-in. pipe, perforated	500 l. f.	1.20	1.36	1.90
30. 15-in. pipe, perforated	450 l. f.	1.50	1.61	2.00
31. Wrought iron pipe	800 lb.	.25	.25	.20
32. 10-in. cast iron pipe	16 l. f.	4.00	6.35	4.00
33. 12-in. cast iron pipe	27 l. f.	4.50	7.24	4.25
34. Gate valve, cast iron, 10-in	1 ea.	60.00	78.83	80.00
35. Frame and cover, manhole	7 ea.	15.00	26.67	14.00
36. Ventilating louvre	26 ea.	10.00	9.66	8.00

WHARF, PROVIDENCE, R. I.

OWNER: Board of Contract and Supply, Providence, R. I.; S. Frank Nolan, city engineer.

PROJECT: Construction of extension to municipal wharf and sea wall, including highways and railroad sidings.

CONDITIONS; All materials to be furnished by contractor who must complete work by June 15, 1940. Rail, highway and water transportation facilities available. Wages are: skilled, $1.35 per hr.; semi-skilled, 60c.; and common, 50c. per hr.

BIDS: Five bids were received March 18, 1940, ranging from the contract low of $107,386 to $142,732.

LOW BIDDERS:

1. M. A. Gammino Constr. Co., Providence, R. I. (contract)..... $107,386
2. John J. McHale & Sons, Inc., Pawtucket, R. I. 120,709
3. John Ambrose Constr. Co., Cranston, R. I..... 132,347

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Broken stone pavement base, 7-in. laid	38,080 s. y.	$0.94	$1.00	$1.70
2. Penetration macadam pavement, 2¾-in. laid	38,080 s. y.	.64	.55	.42
3. Rein. conc. gutters and base	3,200 s. y.	2.00	2.25	3.10
4. Railroad sidings	6,470 l. f.	5.00	5.50	6.25
5. Conc. boxes and drains for switch stands	6 ea.	125.00	150.00	90.00
6. Mooring bitts and anchorages	18 ea.	450.00	1,000.00	50.00

HIGHWAYS, WYOMING

OWNER: Wyoming State Highway Commission, Cheyenne; J. F. Jacques, engineer.

PROJECT: Construction 9.448 miles of Star Valley-Cokeville Road in Lincoln County, Wyo. Includes grading, draining, base course surfacing, four reinforced concrete culverts, five reinforced concrete culvert extensions and other miscellaneous work. Roadway 30-ft. wide. Pit run heavy base course, 2-in. maximum.

CONDITIONS: Contractor to furnish all materials and complete work in 100 working days commencing 20 days after notice of award. Highway transportation facilities available. Wage rates stipulated are: skilled labor, 80c. to $1.12 per hr.; semi-skilled, 65c.; and common labor, 55c. per hr.

BIDS: Nine bids were opened March 21, 1940, ranging from the contract low of $74,014 to $85,371.

LOW BIDDERS:

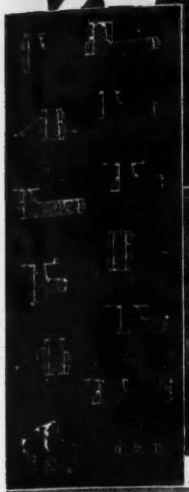
1. John M. Keahey, Buffalo, Wyo. (contract)... $74,014
2. Blanchard Brothers, Cheyenne, Wyo..... 75,059
3. Inland Constr. Co., Omaha, Neb..... 75,306

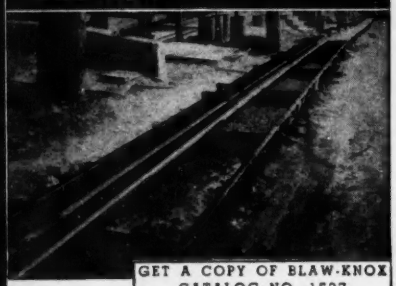
Item	Quan.	Unit Prices (1)	(2)	(3)
1. Excavation	149,500 c. y.	$0.105	$0.10	$0.11
2. Watering (embankment)	1,150 M gal.	1.00	2.50	1.20
3. Roller operation (embank.)	1,500 hr.	2.00	1.50	2.00
4. Structure excavation	290 c. y.	.75	1.00	1.20
5. Excavation, pipe culverts	1,428 c. y.	.35	.50	.50
6. Overhaul	87,400 y. sta.	.015	.015	.015
7. Cu. yd. mile haul	5,200 y. mi.	.12	.10	.14
8. Class A concrete	370.3 c. y.	20.00	20.00	20.00
9. Reinforcing steel	34,550 lb.	.06	.055	.05
10. Structural steel	3,760 lb.	.10	.06	.06
11. 18-in. corr. metal pipe	1,096 l. f.	1.80	1.83	1.60
12. 24-in. corr. metal pipe	918 l. f.	2.75	2.50	2.50
13. 30-in. corr. metal pipe	310 l. f.	3.25	3.25	3.10
14. 36-in. corr. metal pipe	2,590 l. f.	5.00	5.00	5.20
15. Relaying pipe	48 l. f.	.50	1.00	1.00
16. Mechanical tamping	601 hr.	2.00	1.75	1.40
17. Class 1 riprap	165 c. y.	2.50	3.00	2.00
18. Std. rt.-of-way fence	3,000 l. f.	.10	.06	.05
19. Type A rt.-of-way fence	1,500 l. f.	.10	.20	.12
20. Remove, reset rt.-of-way fence	70,500 l. f.	.01	.025	.03
21. End panels	10 ea.	10.00	6.00	4.00
22. Brace panels	4 ea.	10.00	4.00	3.00
23. Right-of-way markers	11 ea.	5.00	5.00	7.00
24. Rein. conc. project markers	3 ea.	10.00	20.00	12.00
25. Old road obliteration	1.5 mi.	160.00	100.00	200.00
26. Remove existing structures	L. S.	250.00	300.00	250.00
27. Treated timber	.923 Mbm.	125.00	150.00	150.00
28. 2-in. pit run heavy base crse	48,000 ton	.275	.30	.29
29. Watering (base)	700 M gal.	1.00	1.15	1.20
30. Roller operation (base)	310 hr.	2.00	4.00	3.50
31. End Panels	125 ea.	10.00	6.00	4.00
32. Brace panels	60 ea.	10.00	4.00	3.00
33. Fence posts (material)	3,480 ea.	.50	.35	.45
34. Barbed wire (material)	4,700 rod	.20	.10	.06
35. Stays (material)	2,250 ea.	.10	.05	.04
36. Woven wire (material)	225 rod	.75	.20	.06
37. Remove, reset telephone line	3.2 mi.	50.00	100.00	120.00
38. Telephone poles (material)	10 ea.	2.50	10.00	15.00
39. Telephone wire (material)	210 rod	.20	.20	.07

"HOW DO I MAKE MONEY ON THESE SMALL JOBS?

Why—I have a set of BLAW-KNOX STEEL FORMS which will build most any cross section I bid on. Steel gives a nice, dense, smooth finish—expensive hand finishing unnecessary.

NATURALLY MY COSTS ARE LOW."





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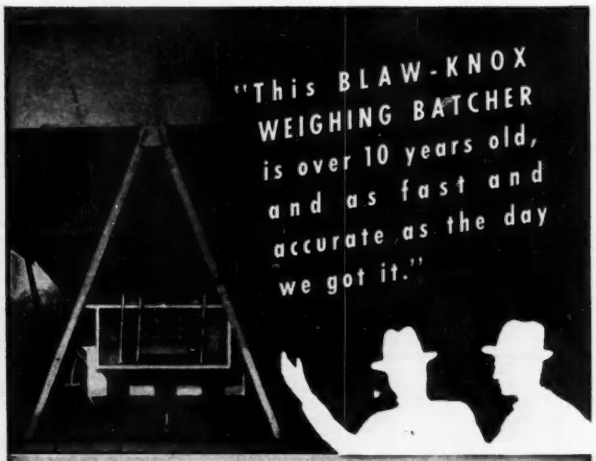
BLAW-KNOX BLAW-KNOX DIVISION OF BLAW-KNOX CO. Farmers Bank Bldg. Pittsburgh, Pa.

Street and Sidewalk STEEL FORMS



Built for maximum speed and accuracy in measuring AGGREGATES, CEMENT AND WATER, Blaw-Knox Weighing Batchers are standard equipment in widespread use by road contractors, for general construction, material yards, and ready mixed concrete plants. They satisfy all modern specifications. Furnished for manual or automatic operation.

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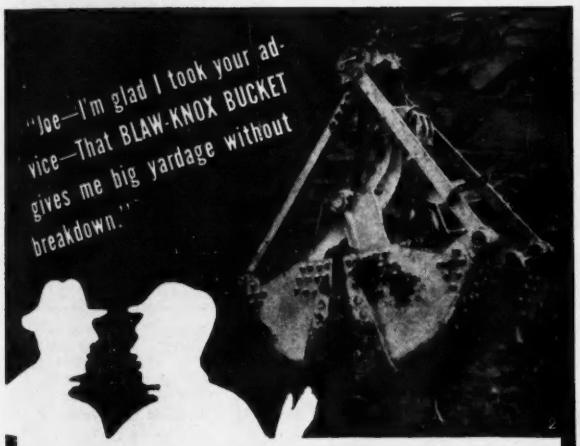
BLAW-KNOX BLAW-KNOX DIVISION OF BLAW-KNOX CO. Farmers Bank Bldg. Pittsburgh, Pa.

Weighing Batchers



2

● Contractors know that the proper use of modern steels and alloys at critical points is their assurance of long uninterrupted service when they buy a Blaw-Knox Bucket.

If you aim to increase yardage and efficiency, to reduce maintenance costs and prolong the life of your buckets—investigate Blaw-Knox Buckets for all kinds of digging and rehandling. Send for Blaw-Knox Bulletin No. 1561.

BLAW-KNOX DIVISION of Blaw-Knox Company
FARMER'S BANK BUILDING PITTSBURGH, PENNA.
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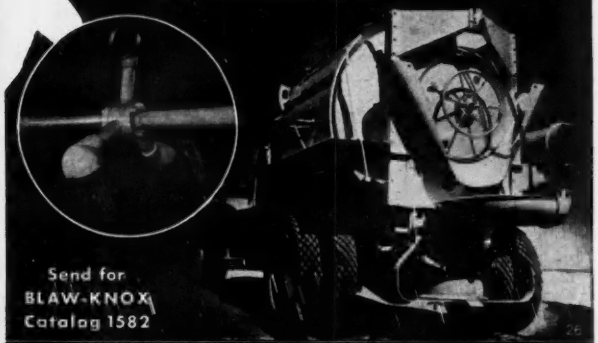
BLAW-KNOX Clamshell BUCKETS

FAST WATER!

"MAN... That new WATER IMPELLER in BLAW-KNOX TRUKMIXERS puts water into the batch in one-third the time formerly required."

The new, fast water impeller that won't clog; an accurate and dependable water measuring system; superb mixing action—and assurance of dependable continuous operation make Blaw-Knox Trukmixers the popular choice, and the practical buy for you. Study these features before you decide.



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BLAW-KNOX BLAW-KNOX DIVISION OF BLAW-KNOX CO. Farmers Bank Bldg. Pittsburgh, Pa.

Agitators and TRUKMIXERS

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

LUMBER provides the most important construction material price change for May. Short leaf yellow pine is 50c. to $1.00 lower in Atlanta; off $3.00 to $4.00 in Chicago; but up 50c. on 1-in. sizes in St. Louis. Pine is $2.00 lower in Boston, and spruce is also off $2.00 on 2-in. sizes there. Douglas Fir is $1.00 to $2.00 lower in both Boston and Chicago; and generally 50c. lower in Montreal.

Cement is 29c. per bbl. lower in Detroit, the only change in the 20 cities. Ready-mixed concrete is down 25c. per cu. yd. in Cleveland and New York, and off 30c. in Minneapolis. Paving asphalt is down 75c. per ton in Cleveland, 45c. in Detroit, and up $1.60 in Seattle.

Reinforcing steel bars are off 12c. in Boston, and expanded metal lath is up 50c. in Chicago, the only changes in *ENR* reported iron and steel prices for the month.

Vitrified sewer pipe prices are down in Boston, Cleveland and New York, and concrete sewer pipe and clay drain tile are also lower in Boston.

The former St. Louis carpenters' rate, $1.25 to $1.50 per hour, now is a straight $1.50 per hour. Common labor on heavy construction in St. Louis which formerly ranged from 45 to 87½c. per hour, has closed that gap, and the top rate now prevails.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT			SAND AND GRAVEL			CRUSHED STONE		CRUSHED SLAG		CONCRETE
	Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included			Per ton, carload lots			Per ton, carload lots		Per ton, carload lots, f.o.b. plant		Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags*a*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.65	....	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.70‡	1.70‡	1.20‡	1.75‡	1.75‡	1.75‡	1.75‡	6.50
Birmingham	2.50	2.25	2.05	1.80	1.80	1.50	1.00	1.00	.90	1.15	5.80
Boston	2.75*b*	2.50*b*	2.30	1.10‡	1.10‡	.80‡	1.10‡	1.10‡	....	....	6.75*m*
Chicago	2.60	2.35	2.20	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.00	1.75	....	1.45*i*	1.45*i*	1.45*i*	1.70*i*	1.70*i*	1.70*i*	1.70*i*	6.55*i*
Dallas	2.30	2.05	1.85	2.00*p*	2.00*p*	1.50*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.00	2.75	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.23	1.98	1.78	1.30	1.40	.80	1.30	1.45	1.02‡	1.14‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.90*n*
Los Angeles	2.82*b*	2.62*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	3.00	2.75	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.35*j*
Montreal	....	1.75*r*	1.60*r*	....	....	1.25‡	.85‡*c*	1.00‡*c*	....	....	6.45*l*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.40*de*	1.40*de*	.90*de*	1.65*de*	1.75*de*	....	....	7.00
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.40‡	1.40‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.50
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85*h*	.85*h*	.75*g*	.75*g*	7.50
San Francisco	2.72	2.52	2.20	1.36	1.36	1.36	1.46	1.46	....	....	7.63
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c. per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Norfolk, Va	1.65	1.60	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Northampton, Pa	1.55	1.50	Waco, Tex. (5c. Tax inTex.)	1.75	1.70
Independence, Kans	1.70	1.65	North Birmingham, Ala	1.70	1.65	Montreal	1.55	1.55

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS	ASPHALT EMULSION (Quick-breaking)
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Per ton, less than 80 penetration		Per gal. 80-300 penetration		Per ton		Per gal.	Per gal.
				Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$16.60*e*	$22.83*e*	$0.0645*e*	$0.1165*e*	$0.0684*he*	$0.1207*h*	$0.0634*e*	$0.0644	$0.0684
Baltimore	145.00‡	44.00‡	2.75	14.00	20.00	.06	.09	.065*h*	.115*h*	.....	.....	.....
Birmingham	.....	28.50*j*‡	.....	19.20	25.20	.0797	.1097	.0834*h*	.1334*h*	.....	.....	.....
Boston	90.00	47.00	3.25	14.00	20.00	.06	.09	.065*h*	.115*h*	.....	.09‡	.12‡
Chicago	140.00	50.00	1.80*d*	14.00	18.00	13.00*g*	17.00*g*	.06*h*	.10*h*	.035	.08	.12
Cincinnati	112.00	37.50	.....	14.31	18.31	.10	.....	18.00	.....	.0525	.....	.08
Cleveland	110.00	37.50	2.80	14.50	19.50	.065	.075	.07*h*	.085*h*	.0375	.08	.09
Dallas	.....	30.00	.....	13.25	20.30	.06	.103	15.00	24.80	.055	.05/.07	.07/.09
Denver	.....	27.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	.....	13.15*f*	18.45*f*	.061	.0984	13.15	17.20	.0475	.061	.0923
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	6.50*b*	15.00	6.50*bg*	15.00*bg*	5.50*b*	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	.....	.....
Montreal	75.00	.....	3.62	14.60	21.25	.105	.1375	.101*h*	.121*h*	.07	.135	.188
New Orleans	.....	.....	.....	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	.....	.078	.....
New York	.....	.....	2.75	15.00	21.00	.06	.09	.065*h*	.115*h*	.....	.07	.11
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	135.00	38.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	110.00/121.00	37.00	.....	14.00	19.00	14.00*g*	19.00*g*	.06*h*	.095*h*	.04	.09	.125
San Francisco	.....	70.00	.....	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0475	.117
Seattle	.....	60.00*c*	.....	15.31	23.51	.....	24.11*g*	10.11/11.11	23.61/24.61	8.36*g*	.0575*i*	.1308*i*

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in.

(Continued on page 104)

The Job You Want Done Is *Now* Being Done

with CUMMINS Dependable DIESELS

This broad experience *Plus* the Cummins Warranty is your protection when you buy a Cummins Diesel

CUMMINS ENGINE COMPANY • COLUMBUS, INDIANA

(Continued from page 102)

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet b	RIVETS ½-in. structural	WIRE NAILS Base d	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std. Spikes c	Tie Plates c	Track Bolts
Birmingham	$2.10	$1.90	$3.40	$2.55	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	1.90	3.40	2.55	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	1.90	3.40	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	1.90	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	1.90	3.40	2.55	....	....	....	....	....	....	....	....
Youngstown	....	1.90	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.00‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45a	2.25a	....	....	2.85a	....	....	....	....	....	....	....
Pacific ports	2.70a	2.25a	....	....	2.90a	....	....	....	....	3.00	2.25	....

‡ Delivered. a F.o.b. cars dock. b Rail steel same as billet prices. Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. d Add switching charge $18 per c.l. c Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS* Per 100 lb., ¼ in., base price 15 tons or over b New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH—Per 100 sq.yd., carload lots— Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING—Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.39	$2.39	.02½	.10	$21.00	$23.00	$1.82	$1.35	$0.1719	$3.04
Baltimore	3.60	2.85	2.70	.....	.10	21.00	23.00	1.70	1.27	.1611	2.75
Birmingham	2.10a	1.90	1.90	.02½	.10	19.50	21.50	1.80	1.34	.1701	....
Boston	3.85	2.61	2.46	$20 C.L.	.10	21.50	23.50	1.76	1.31	.1656	3.14
Chicago	2.10a	1.90	1.90	.03	.05	19.50	21.50	1.67	1.25	.1575	2.40
Cincinnati	3.68	2.51c	2.51c	.....	.05	20.50	22.50	1.66	1.25	.1566	....
Cleveland	3.58g	1.90	1.90	.02½	.10	20.50	22.50	1.66	1.25	.1566	....
Dallas	4.75	3.25	3.25	.....	.....	25.00	27.00	1.93	1.42	.1827	....
Denver	4.35	3.95	3.80	.....	.....	23.50	25.50	1.97	1.45	.1863	....
Detroit	3.60‡	2.00	2.00	.....	.10	22.50	24.50	1.68	1.26	.1584	2.66
Kansas City	4.03	2.51c	2.36c	.0	.05	18.50	20.50	1.78	1.33	.1683	2.86
Los Angeles	3.65f	2.55	2.40	.02½	.05	23.00	27.50	1.93	1.42	.1827	3.65
Minneapolis	3.80‡	2.48c	2.48c	.0	.10	21.50	24.50	1.80	1.34	.1701	2.73d
Montreal	3.90	2.70	2.60	.....	.....	26.50	29.00	2.99	2.08	.319	....
New Orleans	4.40	2.52	2.52	.05	.10	21.50	23.50	1.82	1.35	.1719	2.875
New York	3.75	2.39	2.39	.....	.10	20.50	22.50	1.76	1.32	.1665	2.74
Philadelphia	3.55	2.66	2.56	.....	.....	19.50	21.50	1.71	1.28	.1611	2.72
Pittsburgh	2.10a	1.90	1.90	.02½	.10	21.50	24.50	1.59	1.20	.1503	2.40
St. Louis	3.47	2.39	2.39	.0	.05	24.00	28.00	1.69	1.27	.1602	2.70
San Francisco	3.35	2.525	2.375	.02½	.10	19.00	25.50	1.93	1.42	.1827	3.25
Seattle	2.70e	2.25e	.....	.....	.....	25.50	27.50	1.93	1.42	.1827	2.90e

‡ Delivered. a Mill prices. b 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. c 20 tons or over Base. d Mill price plus freight. e F.o.b. dock. f Includes delivery in free delivery zone. g Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.a	VITRIFIED SEWER PIPE Per foot, 8 in., s.s.	delivered 12 in., s.s.	ASTM 24 in., d.s.	C13–35 36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, 6 in.	f.o.b. 8 in.	CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, h 1 to 3 in., Black %	Butt Weld 3½ to 6 in., Galv. %	Lap Weld Black %	Galv. %
Atlanta	$49.40	$0.26bc	$0.468bc	$1.8525	$4.68c	$85.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2
Baltimore	52.80	.30	.55	2.30	6.80	110.00	150.00	.40	1.60	65.5	57.5	63.0	54.5
Birmingham	45.00	.26	.468	1.854	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	55.00	.231	.4455	1.89	5.2275	180.00‡	280.00‡	.40	2.00	64.1	56.1	61.6	53.1
Chicago	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	52.70	.245	.4995	1.9335	5.6375	105.00	170.00	.60	1.70	65.9	57.9	63.4	54.9
Cleveland	54.24	.21	.405	1.665	4.8175	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	58.20	.265	.477	1.728	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	60.60	.24†	.52†	2.16†	.....	130.00	240.00	.....	.....	58.4	50.4	55.7	47.2
Detroit	54.24	.245	.4725	1.935	4.408	66.45	105.00	.33	1.50	66.3	58.3	63.8	55.3
Kansas City	55.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	56.8	47.8	54.3	44.8
Minneapolis	57.20	.24†	.432†	1.728†	4.60†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.55	.90	3.68	5.95e	135.00‡	260.00‡	.48	1.92	.....	.....	.....	.....
New Orleans	51.38	.26	.48	1.69	.....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	52.20	.29	.60	2.32	6.25	.....	.....	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	50.90	.21	.405	1.75	5.05	100.00	160.00	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85g	2.00g	68 5i	60.5i	66.0i	57.5i
St. Louis	52.48	.24	.432	1.728	3.96	85.00	170.00	.75j	1.80k	65.1	57.1	62.0	53.5
San Francisco	55.00	.3275d	.5895d	2.358	5.895	107.25	178.75	.45	2.50	.....	.....	.....	.....
Seattle	55.35	.35	.63	2.52	6.30	72.00	175.00	.45f	1.40f	.....	.....	.....	.....

‡ Delivered. † F.o.b. a B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. b Double strength. c List to dealer. d List. e 30-inch. f Less 5% for cash. g Culvert pipe. h Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¾ in., 8¼c.; 1 in., 11¼c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58¼c.; 3 in., 76¼c.; 4 in., $1.09; 6 in., $1.92. i Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 24, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld—2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. j Reinforced; spec. C 75-37. k Reinforced; spec. C 75-37.

(Continued on page 106)

PLAY BALL! is in the Headlines

"They laughed when I stepped up to the mound to inaugurate the '40 season. They didn't know that I pitch a 24-hour-a-day, 365-day-a-year game in bigger lots than this, the world over—that in my league I'm tops because *my control is perfect*.

"When the man behind the mask signals for a *fast one*, I can pour it *right down the groove*. When he calls for *curves*, I have thousands of volt-amp. curves to give him his heart's desire. I can burn 'em across the plate, skim along the edge or nip the corners. My delivery is smooth in all styles—south-paw, down-hand or overhead because my arc is *stabilized*.

"This *perfect control* is the result of the New *'Shield-Arc'* (or *'Shield-Arc Jr.'*) with its Job Selector and Stabilized Current Control. They give me fine, accurate control of both slope of volt-amp. curve (ARC BEHAVIOR) and amperage (ARC INTENSITY). No other welding team has this winning combination. Try us.

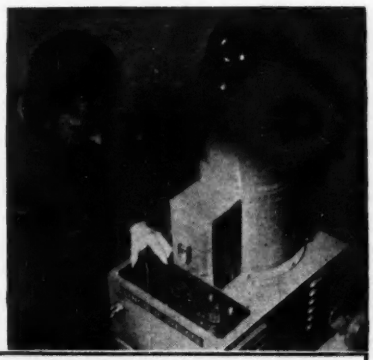
"Yours for a bigger welding gate and more satisfied fans for your products or services,

"FLEETWELD ROD"
World's Most Famous Welding Pitcher,
Owned, Controlled, and For Sale by
THE LINCOLN ELECTRIC COMPANY,
Cleveland, Ohio.

Largest Manufacturers of Arc Welding Equipment in the World.

A HIT!

Users of the New 200-amp. *"Shield-Arc Jr."* report that this $243 welder covers the entire welding front. This all-purpose d. c. outfit enables you to do *more* welding and to do it *faster* and *easier*. Can be used on any thickness of plate. Welds all common metals and alloys—all types and sizes of work. Current range 40 to 250 amps. Accurate arc control with Job Selector. Big overload capacity. Get details today!



Call the nearest Lincoln office or mail the coupon for details.

THE LINCOLN ELECTRIC CO., Dept. F-20, Cleveland, O.

Send free bulletin on New motor-driven *"Shield-Arc Jr."*

Name _____ Position _____

Company _____

Address _____

City _____ State _____

LINCOLN "SHIELD-ARC" WELDERS

The *head line* for profits on the welding front

(Continued from page 104)

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) — All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6, S4S	1x8, S4S	2x4, S4S	2x6, S4S	2x8, S4S	2x10, S4S	3x12, R or S	6x12, R or S	12x12, R or S	2x12, R or S	12x12, R or S	⅝"	¾"
Atlanta	$18.50	$18.50	$17.50	$18.50	$19.00	$19.00	$25.00	.....	.....	$37.50	$50.50	$17.75	$21.60
Baltimore	30.00	31.50	36.50	35.50	36.00	37.00	45.00	.....	.....	68.00	68.00	17.35g	21.15g
	32.00	32.00	34.00	33.00	34.00	64.00	45.00	$46.00	$42.00	.....	.....	.....	.....
Birmingham	22.50	23.50	22.00	21.00	22.00	23.00	37.00	36.00	36.00	.....	.....	16.25	19.85
[1]	25.50	25.50	29.00	27.00	29.00	40.00	60.00	.....	.....	54.00	57.00	.....	.....
Boston	30.00[2]	30.00[2]	32.00[2]	32.00	53.00[1]	60.00[1]	77.00[1]	.....	.....	77.00	77.00	17.35g	21.15g
	28.00	28.00	32.00	32.00	38.00	38.00	45.00	45.00	45.00	.....	.....	.....	.....
Chicago	31.00	31.00	30.00	30.00	30.00	31.00	50.00	.....	.....	80.00	90.00	13.15	16.05
	36.00	36.00	37.00	37.00	38.00	39.00	43.00	42.00	42.00	.....	.....	.....	.....
Cincinnati	31.50	33.00	30.50	31.00	32.00	35.00	44.50	.....	.....	53.00	56.00	16.25	19.85
	.....	.....	.....	.....	.....	.....	46.00	46.00	46.00	.....	.....	.....	.....
Cleveland	32.00	32.50	33.00	33.00	36.00	38.00	45.00	46.00	46.00	80.00	80.00	16.70	20.40
Dallas[e]	28.50	32.50	31.50	29.00	30.50	32.50	52.50	52.50	52.50	63.50	71.00	13.90	16.95
Denver [‡]	47.00[4]	45.00[4]	42.00[4]	40.00[4]	40.00[4]	45.00[4]	48.00[4]	60.00[4]	71.50[4]	.....	.....	9.90	12.05
Detroit	35.00	35.00	35.00	35.00	38.50	42.00	46.00	.....	.....	43.50	58.00	16.25	19.85
	.....	.....	.....	.....	.....	46.00	47.00	54.00	54.00	.....	.....	.....	.....
Kansas City	28.00	29.00	29.00	28.00	29.00	30.00	35.00	.....	.....	55.00	60.00	12.25	14.95
	29.00	29.00	30.00	28.50	29.00	30.00	35.00	39.00	39.00	.....	.....	.....	.....
Los Angeles [a]	36.00	35.00	36.00	33.00	33.00	33.00	38.00	46.00	39.00	.....	.....	9.35gh	11.35gh
Minneapolis [‡b]	47.00[6]	47.00[6]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.05	14.70
[‡]	38.00	38.00	39.00	39.00	39.00	39.00	59.00	59.00	59.00	.....	.....	.....	.....
Montreal [7]	34.00	36.00	32.00	34.00	36.00	42.00	45.00	.....	.....	155.00	165.00	.....	.....
	52.00	54.00	52.75	55.75	57.75	60.75	52.00	52.00	52.00	.....	.....	.....	.....
New Orleans	24.00	25.00	25.00	24.00	24.00	25.00	46.00	.....	.....	62.00	69.00	13.90	16.95
	29.00	29.00	32.00	33.00	36.00	34.00	36.00	.....	.....	.....	.....	.....	.....
New York [‡]	38.00	39.00	37.00	38.00	38.00	39.00	42.00	.....	.....	80.00f	82.50f	17.35g	21.15g
[‡]	.....	.....	45.00	45.00	45.00	45.00	45.00	47.50	47.50	.....	.....	.....	.....
Philadelphia	24.00	24.50	25.50	25.50	27.50	27.50	29.00	.....	.....	50.00	57.50	17.35g	21.15g
	35.00	36.50	39.00	38.25	39.00	39.00	44.00	32.00	32.00	.....	.....	.....	.....
Pittsburgh	38.10	39.90	47.05	42.00	45.65	46.90	59.70	.....	.....	.....	.....	17.00	20.70
	51.80	49.60	49.60	49.00	48.90	49.25	66.55	66.55	66.55	.....	.....	.....	.....
St. Louis [‡c]	32.50	33.50	32.00	31.00	32.00	33.00	47.00	51.00	51.00	73.00	72.00	13.90	16.95
San Francisco [d]	22.50	23.00	23.00	22.50	22.00	22.50	23.50	23.50	23.50	.....	.....	7.30g	8.90g
Seattle	21.00	21.00	21.00	21.00	21.00	21.00	26.00	26.00	26.00	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [6] Spruce. [7] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft.

NOTE: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on ⅝", $77.00; on ¾", $84.80; price includes oiling and sealing charges. For other centers add rail freight increment from table for proper size. For resin dipped treatment, add $10.50 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness		EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
	A quality	B quality	
Atlanta	75%	75%	$0.15
Baltimore	83%	82%	.15
Birmingham	89%d	85%d	.105
Boston	82%	82%	.15
Chicago	79%	79%	.15
Cincinnati	79%	79%	.15
Cleveland	79-10-10%	79-10-10%	.19
Dallas	78%	78%	.165
Denver	76-10%	76-10%	.15e
Detroit	79-10%	79-10%	.15
Kansas City	79-10%	79-10%	.155
Los Angeles	86%d	88%d	.1575
Minneapolis	76%	76%	.155
Montreal	60-5%ab		.17†
New Orleans	70%	75%	.16
New York	82%	83%	.20f
Philadelphia	82-10%d	83-10%d	.15
Pittsburgh	79%	79%	.1425
St. Louis	79-10%	79-10%	.155
San Francisco	78%d	83%d	.155
Seattle	85%d	88%d	.1575

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla.	$0.105	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla.	.11 –.12	.135 –.15	.155 –.17
Rocky Mtn. States	.11 –.1325	.13 –.145**	.15 –.165**
Pacific N. W. States	.1075–.115	.1375–.15	.1575–.17
Pacific S. W. States	.1050–.1175	.135 –.1475	.155 –.1625

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf — Barge	Short Leaf — Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6" x 8" x 8' Untr.	6" x 8" x 8' Tr.	7" x 9" x 8'6" Untr.	7" x 9" x 8'6" Tr.
Boston	Oak	$1.20	....	$1.65	....
	Pine	1.50	$2.25a	2.25	$3.20a
New York	S. L. Sap Pine	1.10/1.20	1.85	1.50	2.35
	Mixed Oak	1.45	1.95	1.90	2.45
Birmingham	White Oak	.85	1.50a	1.35	1.70a
	Southern Pine	.55b	1.10ab	.70	1.30a
Chicago	Oak	....	1.65a	....	2.25a
	Southern Pine	....	1.53a	....	2.13a
Los Angeles	Douglas Fir	.64	1.38a	.90	1.80a
Philadelphia	Red Oak	1.10	....	....	2.40a
St. Louis	White Oak	1.12	....	1.50	....
	Red Oak	1.12	1.60a	1.50	2.05a
	Sap Pine or Cypress	1.02	....	1.40	....
San Francisco	Douglas Fir	.90bcf	....	....	1.95ca/
Montreal	Birch or Maple	.65	1.05a	.75	1.35a

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb.	$2.00–2.85
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	22.00–35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb.	4.60

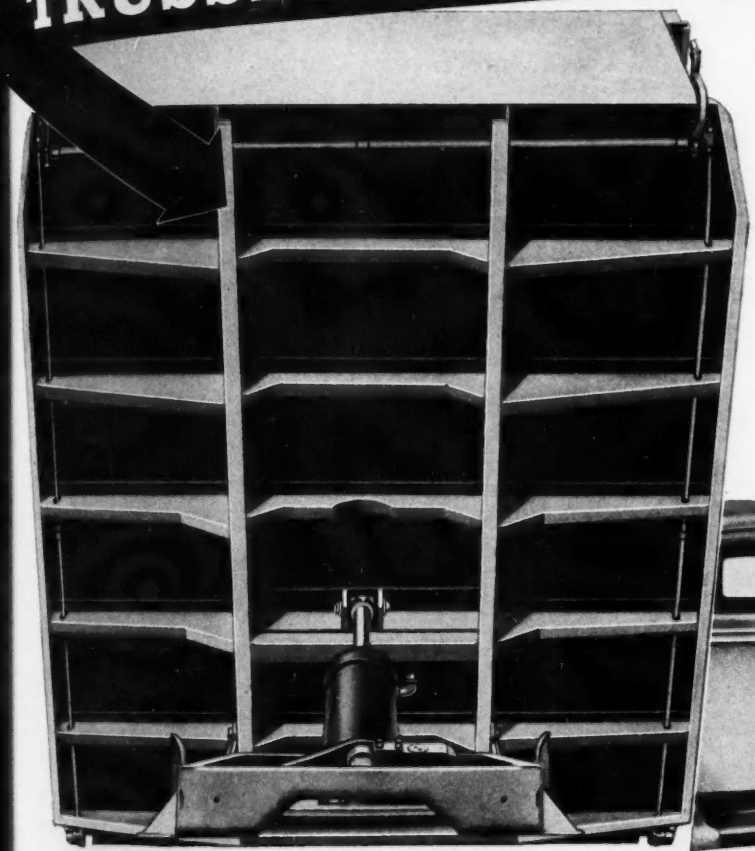
(Continued on page 108)

GAR WOOD offers EXCLUSIVELY

THE SCIENTIFICALLY ENGINEERED (PATENTED)

The Greatest DEVELOPMENT IN DUMP BODY CONSTRUCTION

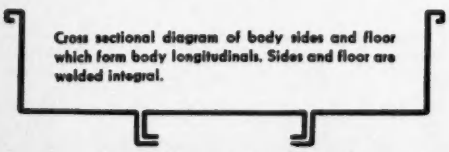
TRUSSED UNDER-STRUCTURE



Only Gar Wood dump bodies have these outstanding features: (1) Direct full-length support to floor by integral longitudinals in combination with new trussed-type crossmembers, results in most rigid construction. (2) Sides and floor sections which form body longitudinals are welded integrally by the newest scientific method—giving maximum strength to floor in resisting shocks and sudden load impacts. (3) Greatest strength in the center area of the floor (which is subjected to more abuse) than is possible with the conventional type of body under-structure.

The well-known "C" line of Gar Wood Bodies used with Models D6, D7 and F1CS Hoists, are supplied in all types and sizes with the new trussed under-structure—at no increase in present body prices.

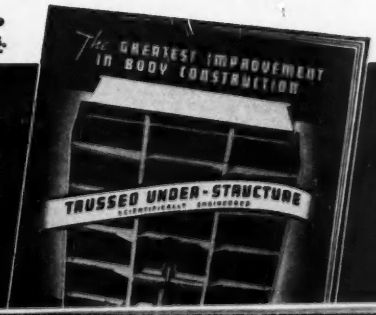
SIDES AND FLOOR FORM BODY LONGITUDINALS → WELDED INTEGRAL



Cross sectional diagram of body sides and floor which form body longitudinals. Sides and floor are welded integral.

Gar Wood Hoists and Bodies are the world's best sellers! Due to this buyers' acceptance and preference, more and more contractors, municipalities, governmental agencies, individual users, truck distributors and truck dealers are specifying Gar Wood equipment—universally recognized as the most dependable and the most economical for every hauling requirement.

Write or ask for BULLETIN 26 describing the newest Gar Wood trussed under-structure, also new BULLETIN 7 featuring the complete line of Hoists and Bodies for 1½ TO 2-TON TRUCKS.



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WORLD'S LARGEST MANUFACTURER OF TRUCK AND TRAILER EQUIPMENT

BRANCHES AND DISTRIBUTORS EVERYWHERE

...ck and Bodies • Truck Tanks for Fuel-Oil, Gasoline, Milk and other Liquids • Winches and Cranes
Roadbuilders • Bulldozers • Scrapers • Tamping Rollers • Rippers